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CONTENTS

Studies on the variability and dissociations in the genus Fusarium. LEON H. LEONIAN 753

Observations on Armillaria root rot of orchard trees. LEROY CHILDS and S. M. ZELLER 869

The effect of grafting on resistance and susceptibility of beans to Colletotrichum lindemuthianum. J. G. LEACH 875

Phytopathological Notes 879

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PHYTOPATHOLOGY

VOLUME 19 NUMBER 9

SEPTEMBER, 1929

STUDIES ON THE VARIABILITY AND DISSOCIATIONS IN THE GENUS FUSARIUM[1, 2]

LEON H. LEONIAN

PREFACE

BY C. D. SHERBAKOFF

Because of my interest in Fusaria the author of this paper has asked me to write a brief statement as a preface to his work, kindly giving me full freedom to say whatever I please.

I consider the data presented in this work to be a distinct contribution to our knowledge of the behavior of fungi. The introduction and discussion present matter of great interest to me, though I disagree with many of the conclusions and surmises, often characteristic of the mental attitude of many who spend much time on the taxonomy of Fusaria but whose main interest is in other subjects.

The experiments herein reported and the results obtained were initiated and are discussed primarily from the point of view of their bearing upon the taxonomy of Fusaria; hence, this phase must be given primary consideration.

A classification of organisms, to be of fundamental value, must aim at their genetic grouping. In the case of Fusaria, at least for the time being, we have at our disposal only indirect means for the determination of their true relationship; namely their morphological and physiological characters. Therefore, the more that is known of these characters the better shall we be prepared for a correct classification. Hence, the value of the present paper. In regard to the inadequacy of the present classification here referred to, however, it should be remembered that, so far, only a few men have given systematic attention to this subject and that the first work of value on Fusaria appeared only eighteen years ago.

There is no question that the variability of Fusaria is thoroughly demonstrated by the experiments as reported in this paper and thus they emphasize further the similar findings of other workers. The variability is, how-

[1] Published by the permission of the Director of the West Virginia Agricultural Experiment Station as Scientific Paper no. 56.

[2] The major part of the cost of publishing this paper was borne by the West Virginia Agricultural Experiment Station.

ever, primarily of the "presence and absence," and of the "more and less" type, which usually is of a barking rather than a biting kind. It will often be found more apparent than real, especially in the case of spore characters. This was considered with some emphasis a while back by the author of the preface.[3] While a greater emphasis may well be placed on the conditional variability, the facts now stand in general as they were then.

The experiments herein reported also bring out clearly the fact that organisms, similar in their morphology, usually show a similarity in certain physiological characters and thus, in the identification of Fusaria, physiological characters could be, whenever necessary, used in place of, or supplementary to, morphological characters.

The exceptions to the uniform response, the so-called erratic or inconsistent behavior as observed in all of the tests employed herein, will probably be found, after a thorough revision of the facts involved, either conditional or showing true differences in the organisms concerned.

The appearance of "mutations," "saltations," and "variants," in pure cultures of Fusaria and other fungi, is at present unquestionable. Their significance may be of some genetic and therefore of fundamental taxonomic value, but their importance in the practical identification of certain individual organisms seems to be overemphasized here and in some other works on the subject. At present, when we are quite ignorant of how properly to grow fungi for identification purposes under adequately controlled conditions, the Fusaria must be grown on media known to be most suitable to them. Especially should they be grown on media not too rich in available nitrogen and sugars. These media ordinarily do not cause the fungi to saltate, but thus support unchanged and for a long time the growth of Fusaria of the same kind as the original. For that reason, the so-called natural media are, for the time being, more suitable for morphological studies of Fusaria than the synthetic media though in their composition the former are more variable than the latter.

In regard to the questions and suggestions often heard about the need of radical improvements and changes in the taxonomy of Fusaria, it may be stated that while these are much needed and may finally be quite drastic, they can come only when additional knowledge discloses the true facts and reveals the falsity of the present assumptions. However, the practical need may, and probably will, promote sufficient study of the fungi to devise more dependable and accessible means of identification of individual Fusaria.

The author's suggestion that as many strains as possible of the same species from different parts of the world should be studied is good; however, there is the prerequisite that some dependable means be employed by which the strains may first be properly grouped into the different species. At

[3] Sherbakoff, C. D. Fusaria of potatoes. Cornell Memoir 6: 111–113. 1915.

present, however poor the presentation may be, only the morphological means are known. And here I wish to state that while the details of the present taxonomy of Fusaria are unsatisfactory, its foundation is, in my opinion, sound, though certainly it might be advantageously reinforced by the study of physiological characters.

INTRODUCTION

Variability is a most outstanding character in the genus Fusarium. It has been responsible for many complications which have arisen not only in taxonomy but in pathological relationships, as well. While some excellent work done recently both in this country and abroad has considerably clarified the situation, much more remains to be done.

The species may be highly plastic; yet, notwithstanding its fluctuations and temporary or permanent deviations from the common path, it retains some characteristic landmark whereby its relationships can be traced. Very often such landmarks are in the form of an intangible something which cannot be properly established unless the approximate limits of the variability of the organism are first defined. However, this variability is not a simple phenomenon but the expression of a complex mechanism which has received hitherto but little attention from mycologists. Numerous facts indicate that a given bacterium or fungus may not possess just a single orbit within which certain standardized phenomena manifest themselves in logical sequence, but that two or more orbits of unlike nature may be found woven into the intricate pattern of the protoplasm. Furthermore, any one of these phases may emerge and be perpetuated at the expense of all others provided the proper stimulus be present. The dissociation of these various phases in a given bacterial or fungous colony may be observed in sector formations and in the conflicting responses which the organism often makes under the most strictly controlled laboratory conditions.

The present studies are an attempt to follow the variability of Fusaria from growth reactions, and to untangle, if possible, the continuity of the specific path, thus making some contribution towards the ultimate goal, namely, the crystallization of the species concept.

It was soon observed, as expected, that many of the Fusaria began to form sectors when grown in petri dishes. Transfers made from most of these sectors gave pure cultures of the "new" strain. Large numbers of such strains were isolated in pure cultures and added to the original group of Fusaria. They can be distinguished throughout this paper by the Roman numerals accompanying their names. For example, *F. semitectum XVIII* denotes the eighteenth variant of this particular species.

All organisms were carefully checked in order to reduce any chance contamination to an absolute minimum. When one is constantly working

with nearly three hundred organisms, many of which possess spores capable of being easily carried by air currents, no amount of precaution can assure total freedom from contaminations. Nor can one be certain that cultures coming from other laboratories are always true to name. Consequently, it was found necessary to enlist the aid of C. D. Sherbakoff. After all of the experimental work was concluded, the cultures were submitted to his critical study. As a result of his findings, seven of the variants were discarded because they were believed to be contaminations; nineteen other cultures were eliminated because they were misnamed, and finally twelve more were removed from the general list because they were originally received as unidentified forms and it was deemed best to retain nothing but named species.

The writer doubts if the sectors which appeared in the colonies of Fusaria are true mutations; in fact, he doubts if mutations ever do occur in fungi. He is inclined to agree with some bacteriologists that such phenomena, at least in microbiology, are dissociations rather than mutations. It is very difficult to explain reversible behaviors in the light of mutations, whereas dissociations admirably fit into such conflicting activities. The term variant has been employed here to differentiate the new phases resulting from dissociative phenomena.

Not all of the variants described in this paper are fixed. Although some have been in culture for over three years without any noticeable change in their appearance, too many others have manifested a remarkably reversible fluctuation. In case of some organisms almost every transfer yielded a complex colony with well-defined sectors none of which could be isolated no matter how often the work was repeated. For example, regardless of whether the inoculum was taken from the colorless or colored sectors, the ensuing colony was always complex. In some others, the sectors were readily isolated in pure culture, but after "coming true" for a few months or even a year, they either completely reverted to the old type or again yielded a complex colony. When within a comparatively short period a given fungus fluctuates back and forth a number of times between two morphologically and physiologically different types, notwithstanding the fact that all environmental conditions are kept uniform, the investigator finds no means, other than dissociative phenomena, with which to explain the puzzling situation. This phenomenon will be stressed later in this paper.

Whenever more than one strain of a given organism is listed, it is designated with an Arabic numeral, such as *F. trichothecioides 5*. If such an organism has yielded variants, it is qualified by both Arabic and Roman numerals: for example, *F. trichothecioides 3–II*, which denotes the variant no. II of the strain no. 3. This scheme has been found very convenient for a simple but speedy differentiation of a large number of different forms.

The writer wishes to express his thanks to all his colleagues and friends who sent him cultures, advice, and even sympathy, all of which were sorely needed. He is especially indebted to C. D. Sherbakoff who, from the very beginning, manifested a sympathetic and active interest in the progress of the work. He not only sent cultures, revised the nomenclature, and examined the fungi used in this work, but also critically read the manuscript and made many valuable suggestions.

A considerable proportion of the tedious laboratory routine was shared with the writer by Daisy Chapman and Herbert Geer, for whose efficient assistance I wish to express my deep appreciation.

Finally, I wish to acknowledge gratefully the work of W. E. Rumsey, whose excellent photography materially contributes to this paper.

ORGANISMS, THEIR SOURCES, AND THEIR VARIANTS

An attempt was made to secure not only many different species, but also as many different strains of the same organism as possible. Most of the cultures used in this work, secured through the courtesy of C. L. Shear and Margaret Wilcox, represent the Fusaria which formed the basis of the studies by the Fusarium Conference (10). Another group of organisms came from Holland, and the remainder were secured from miscellaneous sources. As a rule, very few of the tubes showed signs of mites, Actinomyces, or bacterial contaminations. Whenever such foreign organisms were observed, the cultures were freed from them before any experimental work was begun.

The following list represents the different species, varieties and strains of Fusaria that were used in these experiments:

F. acuminatum Ell. & Eve. emend Wr. no. 1. Secured from Shear.

F. acuminatum no. 2. Isolated from sugar beets by Ernest Reed; identified by Sherbakoff. This organism has yielded eight variants.

F. alluviate Wr. & Reink. Secured from Shear.

F. anthophilum (A. Br.) Wr. Secured from Shear.

F. aquaeductuum pusilum Wr. Obtained from Holland.

F. aquaeductuum volutum. Obtained from Holland.

F. arcuatum Berk & Curt. Secured from Shear. According to Sherbakoff this organism is different from *F. arcuatum* Sherb.

F. asclerotium (Sherb.) Wr. Sent by L. R. Jones, who secured the original culture from Wollenweber.

F. aurantiacum (Link.) Sacc. Secured from Shear.

F. batatatis Wr. no. 1. Isolated from sweet potato; sent by L. L. Harter.

F. batatatis no. 2. Obtained from Holland.

F. bulbigenum Cke. & Masse. Secured from Shear.

F. bullatum Sherb. Secured from Shear. This organism has yielded two variants.

F. bullatum brevis Wr. & Reink. Secured from Shear.

F. camptoceras Wr. & Reink. Secured from Shear. This organism has yielded two variants.

F. caudatum Wr. Secured from Shear.

F. chlamydosporum Wr. & Reink. Secured from Shear. This organism yielded three variants.

F. chenopodium (Tuhm.) Sacc. Sent by Sherbakoff.

F. coeruleum (Lib.) no. 1, Sacc. Sent by Freeman Weiss, who isolated it from a potato plant found at State College, Pa. This organism has yielded two variants.

F. coeruleum no. 2. Sent by Weiss, who isolated it from a potato tuber from North Dakota.

F. coeruleum no. 3. Obtained from Holland.

F. commutatum Sacc. Obtained from Holland.

F. conglutinans Wr. Sent by L. R. Jones.

F. cubense E. F. Sm. no. 1.

F. cubense no. 2. This organism was sent from Holland under the name of *F. musae* Drost. Sherbakoff believes it to be *F. cubense*.

F. culmorum (W. G. Sm.) Sacc. no. 1. Obtained from E. C. Stakman. This organism has yielded two variants.

F. culmorum no. 2. Sent by W. E. Maneval.

F. culmorum nos. 3, 4, 5 and 6. Sent by Ernest Reed, who isolated them from sugar beets. Identified by Sherbakoff. Nos. 3, 4 and 6 have yielded two variants each.

F. decemcellulare Brick. Secured from Shear.

F. dimerum Penz. Secured from Shear.

F. diversisporum Sherb. Secured from Shear.

F. ensiforme Wr. & Reink. Secured from Shear.

F. eumartii Carp. no. 1. Sent by Weiss, who isolated it from potato plant at Wanamaker, Pa. This organism has yielded two variants.

F. eumartii no. 2. Sent by R. W. Goss. This organism has yielded two variants.

F. eumartii no. 3. Sent by R. P. White.

F. euoxysporum Wr. Obtained from Holland.

F. falcatum App. & Wr. Secured from Shear.

F. filiferum (Preuss) Wr. Secured from Shear. This organism has yielded two variants.

F. flocciferum Cda. Obtained from Shear.

F. fructigenum Fr. Sent by Sherbakoff.

F. fructigenum maius Wr. forma. 1, Wr. & Reink. Secured from Shear.

F. fructigenum maius no. 2. Secured from Shear under the label of *F. stilboides* Wr. According to Sherbakoff it should be *F. fructigenum maius*. This organism has yielded seven variants.

F. fructigenum maius no. 3. Isolated by Valleau and identified by Sherbakoff. This organism yielded three variants.

F. gibbosum App. & Wr. Sent by Maneval.

F. graminum Cda. no. 1. Obtained from Holland labeled *F. limosum* Rost. According to Sherbakoff it should be *F. graminum*.

F. graminum no. 2. Isolated from lettuce by Valleau and identified by Sherbakoff. This organism has yielded two variants.

F. herbarum (Cda.) Fr. no. 1. Obtained from Holland labeled *F. putrefaciens;* according to Sherbakoff it should be *F. herbarum*.

F. herbarum no. 2. Obtained from Holland labeled *F. metachroum imperfectum* Wr.

F. herbarum gibberalloides Wr. Secured from Shear. This organism has yielded two variants.

F. herbarum pirinum (Fr.) Wr. Isolated by Ernest Reed from sugar beets and identified by Sherbakoff. This organism yielded two variants.

F. hyperoxysporum Wr. no. 1. Secured from Shear.
F. hyperoxysporum no. 2. Sent by R. F. Poole.
F. incarnatum (Desm.) Sacc. Secured from Shear. This organism has yielded four variants.
F. javanicum Koord. no. 1. Secured from Shear.
F. javanicum no. 2. Obtained from Holland.
F. lini Bol. Sent by Otto Elmer.
F. lateritium Nees. Isolated by H. S. Fawcett and identified by Sherbakoff. This organism has yielded two variants.
F. lolii (W. G. Sm.) Sacc. Secured from Shear.
F. lonchecceras Sid. Sent by C. P. Sideris.
F. lonchecceras microsporum Sid. Sent by Sideris.
F. longipes Wr. & Reink. Secured from Shear.
F. lutulatum Sherb. Secured from Shear. This organism has yielded two variants.
F. lycopersici (Sacc.) Wr. no. 1. Secured from Shear.
F. lycopersici no. 2. Sent by E. E. Clayton.
F. malli Taub. Secured from Shear
F. macroceras Wr. & Reink. Secured from Shear.
F. martii App. & Wr. no. 1. Secured from Shear.
F. martii no. 2. Secured from Shear.
F. martii no 3. Sent by Sherbakoff labelled *F. ipomoeae* (Halst.) Wr. In a later communication Sherbakoff writes that "there is no name of this kind but *Hypomyces ipomoeae*, the conidial stage of which much resembles *F. martii*. This organism has yielded two variants.
F. martii minus Sherb. Secured from Shear.
F. martii phaseoli Burkh. no. 1. Sent by J. E. Weimer. This organism has yielded three variants.
F. martii phaseoli no. 2. Obtained from W. H. Burkholder. This organism has yielded two variants, but Sherbakoff thinks that variant no. 2–II is some other fungus. Yet, because this form has appeared repeatedly in single-spore cultures, and, furthermore, because its reactions bear a very close similarity to those of the other strains of this fungus, the organism is retained in this work.
F. martii pisi Jones. Sent by Fred Jones.
F. martii viride Sherb. Secured from Shear.
F. moniliforme Sheld. no. 1. Secured from Shear.
F. moniliforme no. 2. Secured from Shear.
F. moniliforme no. 3. This and the following two cultures were sent by Panos Caldis, who isolated them from the interior of the fig fruit in California.
F. moniliforme nos. 4 and 5.
F. moniliforme crumpens Wr. & Reink. Secured from Shear. This organism has yielded two variants.
F. moniliforme minus Wr. & Reink. Secured from Shear.
F. moniliforme subglutinans Wr. & Reink. Secured from Shear.
F. neoceras Wr. & Reink. Secured from Shear.
F. niveum E. F. Sm. no. 1. Obtained from E. C. Sherwood, who isolated it from watermelon in West Virginia.
F. niveum no. 2. The original of this culture was sent to Sherwood from Oregon.
F. orthoceras App. & Wr. Secured from Shear.
F. orthoceras triseptatum Wr. Secured from Shear.
F. ossicolum (Berk.) Sacc. no. 1. Secured from Shear.

F. ossicolum no. 2. Obtained from Holland under the label of *F. falcatum cespitosum* Wr. According to Sherbakoff it should be *F. ossicolum.*

F. oxysporum Schl. no. 1. Secured from Shear.

F. oxysporum no. 2. Secured from Shear.

F. oxysporum nicotianae John. Secured from Shear.

F. paspalicola P. Henn. Sent by Sherbakoff.

F. pirinum Fr. Secured from Shear.

F. poae (Peck) Wr. Isolated from mustard roots by B. B. Higgins and identified by Sherbakoff. This organism has yielded two variants.

F. polymorphum Matr. Secured from Shear.

F. pusillum Wr. Secured from Shear.

F. radicicola Wr. Secured from Shear.

F. rhizochromatistes Sid. Obtained from Holland.

F. rhizochromatistes microsclerotium Sid. Obtained from Holland.

F. sambucinum no. 1, Fuckl. Secured from Shear.

F. sambucinum no. 2. Obtained from Holland labeled *F. discolor triseptatum.* According to Wollenweber this fungus is same as *F. discolor* which in turn is a synonym of *F. sambucinum* Fuckl.

F. scirpi Lamb. & Fautr. Secured from Shear.

F. sclerostromaton Sid. Obtained from Holland.

F. semitectum Berk. & Rav. no. 1. Secured from Shear. This organism has yielded eighteen strains. Sherbakoff thinks that variant 1–III does not belong here, yet because in all of its reactions it closely resembles the other strains, it is not eliminated from this paper.

F. semitectum no. 2. Secured from Shear.

F. solani (Mart. p.p.) App. & Wr. no. 1. Sent by J. J. Taubenhaus, who isolated it from spinach in Texas.

F. solani no. 2. Isolated from sugar beets by Ernest Reed and identified by Sherbakoff. This organism has yielded two variants.

F. solani no. 3. Isolated from onions by George K. K. Link and identified by Sherbakoff. This organism has yielded three variants.

F. solani no. 4. Isolated from lettuce by Valleau and identified by Sherbakoff. This organism has yielded two variants.

F. solani minus Wr. no. 1. Secured from Shear. This organism has yielded two variants.

F. solani minus no. 2. Isolated from lettuce by Valleau and identified by Sherbakoff. This organism has yielded two variants.

F. solani suffuscum Sherb. Secured from Shear.

F. spinaceae Sherb. no. 1. Sent by Sherbakoff.

F. spinaceae no. 2. Sent by Taubenhaus, who isolated it from spinach.

F. striatum Sherb. no. 1. Secured from Shear. This organism has yielded two variants.

F. striatum no. 2. Secured from Shear.

F. striatum no. 3. Isolated from lettuce by Valleau; identified by Sherbakoff. This organism has yielded two variants.

F. sulphureum Schlecht. no. 1. Sent by Sherbakoff.

F. sulphureum no. 2. Obtained from Holland labeled *F. genevense* Dasc.; according to Sherbakoff it should be *F. sulphureum.*

F. sulphureum no. 3. Obtained from Holland.

F. theobromae App. & Strk. Secured from Shear.

F. tracheiphilum Wr. Obtained from Holland.

F. trichothecioides Wr. no. 1. Sent by Weiss, who isolated it from potato tubers in Outlook, Montana.

F. trichothecioides no. 2. Sent by R. W. Goss. This organism has yielded three variants. Sherbakoff thinks that variant 2–II does not belong here, but it has been retained by the writer because in its reactions it is quite similar to the other strains.

F. trichothecioides no. 3. Sent by Otto Elmer. This organism has yielded two variants.

F. trichothecioides no. 4. Sent by R. P. White. This organism has yielded two variants.

F. trichothecioides no. 5. Sent by Maneval.

F. trichothecioides no. 6. Obtained from Holland labeled *F. tubivorum;* according to Sherbakoff it should be *F. trichothecioides.*

F. trichothecioides no. 7. Sent by J. L. Weimer, who isolated it from bean roots. Identified by Sherbakoff. This organism has yielded two variants.

F. tricinctum (Cda.) Sacc. no. 1. Secured from Shear. This organism has yielded eight variants.

F. tricinctum no. 2. Obtained from Holland. This was originally described as *F. muntzii* Wr.

F. uncinatum Wr. Obtained from Holland.

F. urticearum (Cda.) Sacc. Secured from Shear. This organism has yielded two variants.

F. vasinfectum Atk. Secured from Shear.

F. viride (Lehm.) Wr. no. 1. Secured from Shear.

F. viride no. 2. Obtained from Holland. This organism was originally described as *F. solani medium* Wr.

F. viticola Thum. Secured from Shear.

F. zonatum (Sherb.) Wr. no. 1. Secured from Shear.

F. zonatum no. 2. Sent by Taubenhaus labeled as *F. cepae* Hanz. According to Sherbakoff *F. cepae* should be *F. zonatum.*

F. zonatum no. 3. Sent by L. R. Jones as the original *F. cepae* of Walker and Tims.

MEDIA AND TECHNIQUE EMPLOYED AND TESTS APPLIED

Uniform conditions were maintained throughout these experiments, and no effort was spared to make the quality and the quantity of nutrient agars and solutions as nearly the same as possible. Unless otherwise stated, all cultures were kept at a temperature of 25° C. for two weeks before readings were made. The test-tubes and petri dishes used were uniform in size. The size and age of the inoculum were kept uniform by the following method: Fresh colonies of the fungi were grown in petri dishes and small discs of agar and mycelium were then cut by a cork borer of 5 mm. opening. A row of such discs was cut on a circular line around the colony approximately 5 mm. back of the outermost edge of growing hyphal tips. This region rather than the outermost edge of the colony was used because the young hyphae of the more rapidly growing organisms produce very sparse and superficial growth, and cannot be cut and transferred without greatly disturbing the mycelium. No such practice was found necessary in case of organisms which failed to make colonies larger than 40 mm. in diameter in six days, because such slow-growing organisms have a firm grip on the agar, even at the outermost edge of the growing zone. This method provided a rapid and very simple scheme whereby large numbers of inoculum-discs

could be cut, and each disc lifted and transferred by a platinum needle to any desired container of agar or solution.

Only one nutrient agar was used for stock cultures and it consisted of the following ingredients:

Dry malt extract	10 grams
Dextrose	10 "
Potassium nitrate	2 "
Dihydrogen potassium phosphate	1 gram
Magnesium sulfate	1 "
Shredded agar	20 grams
Distilled water	1,000 c.c.

All the ingredients were cooked together in the autoclave for fifteen minutes at fifteen pounds pressure, then tubed or plated by pouring 10 c.c. in each test-tube (16 x 150 mm.) and 15 c.c. in each petri dish (100 mm. in diameter and 15 mm. deep). The nutrient agar was then sterilized at fifteen pounds pressure for fifteen minutes.

The relative value of each reaction obtained with any of the organisms has been expressed by Roman numerals. Except where the reading stands at 0 on the one hand and I–V on the other, the comparative value of the symbols should not be stressed very much. It is unwise to assume that because an organism under identical conditions shows a growth reaction which is interpreted as I, and another under the same conditions gives a growth reaction estimated as V, there can really be a fundamental difference between the two organisms, or at least one of sufficient merit to be used in differentiative work. This may, perhaps, sound a bit too drastic, but it should be realized that while very often minute details may be of great scientific value, they are perhaps as often sources of much confusion and erroneous conclusions. Consequently, nothing but the high points in the reactions of these Fusaria have been considered.

Simplicity of experiments and elimination of the personal factor were attempted in conducting these studies. After a considerable number of preliminary tests it was decided that growth reaction would give the most dependable results. An inoculum, transferred to a certain solution, either grows or does not grow. In either case the results can be readily seen and interpreted without difficulty or confusion. While it was a comparatively easy matter to prepare solutions which would induce a good growth, much greater difficulty was encountered in a search for growth-inhibiting substances. A variety of supposedly toxic compounds was tried and discarded. It seems that Fusaria have considerable ability to tolerate many such substances in comparatively high concentrations.

One naturally thinks that such a simple thing as growth reaction would show a dependable consistency; but, as revealed in the following tables, a

great number of conflicting results have been encountered in every experiment. It became necessary, therefore, to repeat each experiment at least once, and more often two or three times. Some have been repeated a dozen times. In addition to this, the work was so planned as to check one experiment against others of the same nature, thus attempting to approach a condition where the balance between the organisms and their environment was of such nature as to render fluctuating reactions much less common. Yet, the writer refrains from making any generalization except one: the only constant thing in Fusaria is their inconstancy.

The following is a list of experiments and characteristics with which an attempt has been made to test the variability of Fusaria:

1. Rate of growth of colonies. 2. Production of color and spore masses on five different nutrient agars. 3. Sporulation on malt extract agar. 4. Growth at 5° C., 34° C., and 37.5° C. 5. Growth in presence of nine different concentrations of tartaric acid. 6. Reproduction in presence of nine different concentrations of tartaric acid. 7. Growth in presence of two concentrations of tannin. 8. Growth in presence of two concentrations of mercurochrome. 9. Growth in presence of five concentrations of malachite green. 10. Growth in presence of two concentrations of iodic acid. 11. Growth in presence of one concentration of acid phenol acetic. 12. Growth in presence of two concentrations of sodium dinitrophenoxide. 13. Growth in presence of three concentrations of sodium tribromphenate.

RATE OF GROWTH OF COLONIES

Petri dishes containing 15 cc. of malt extract agar were inoculated and kept at 25° C. for six days, and the diameter of the ensuing colonies was then measured. The results are presented in table 1. The number of measurements accompanying each organism represents the number of times the work was repeated and should embrace the scope of variability characteristic of each organism.

The colors of the six-day-old colonies are given in column 3 of table 1, not with a view to segregating color fluctuations, but because colors are considered as a somewhat significant by-product of the main experiments. The more detailed accounts on pigment formation are given in table 2. No attempt has been made to give the exact shades of mycelium or substratum because at a given time such a terminology might describe the color of a given fungus, but if the work be repeated a sufficiently large number of times, a most disconcerting fluctuation would be revealed. Such different general colors as blue-green, red, purple or violet and lavender may, at one time, be exhibited by the same strain; but upon subsequent trials the fungus may appear without any pigment whatsoever.

Other growth habits, such as the presence or absence of aerial mycelium, its nature, whether fluffy, or appearing as twisted strands, yielding or

TABLE 1.—*Rate of growth and color of colonies on malt extract agar (6 days at 25° C.)*[4]

Organisms	Measurements of Rate of Growth (mm.)	Average Rate of Growth (mm.)	Color
F. acuminatum I	90–90–90–90	90	0
F. acuminatum 2–I	100–100–100–100	100	Red-purple
F. acuminatum 2–II	55–65–90–85–90	77	Pink zone or none
F. acuminatum 2–III	50–60–90–85–90	75	Pink zone
F. acuminatum 2–IV	80–80–75	78	Pink zone
F. acuminatum 2–V	65–55–65	62	0
F. acuminatum 2–VI	85–75–80–75	79	0
F. acuminatum 2–VII	80–80–90–90–85	85	0
F. acuminatum 2–VIII	70–70–90–90–90	82	0
F. alluviale	60–70–60	63	0
F. anthophilum	70–70–65–55	65	0
F. aquaeductuum pusilum	20–25–20	23	0
F. aquaeductuum volutum	20–25–20–20	22	0
F. arcuatum	45–45–45–30	41	0
F. asclerotium	85–80–90–80	84	0
F. aurantiacum	90–85–90–80	86	0
F. batatatis 1	65–70–70–70	69	0
F. batatatis 2	80–90–85	85	0
F. bulbigenum	85–80–85–80	82	0
F. bullatum I	85–85–90–75	84	0
F. bullatum II	65–65–80–90	75	0
F. bullatum brevius	100–90–90–90	92	0
F. camptoceras I	80–80–90–80	82	0
F. camptoceras II	85–85–85	85	0
F. caudatum	90–90–90–85	89	0
F. chlamydosporum I	80–85–90–90	86	Yellow brown center
F. chlamydosporum II	65–75–85–75	75	Orange
F. chlamydosporum III	90–90–85–90	88	Yellow-brown center
F. chenopodinum	90–85–85–90	87	0
F. coeruleum 1–1	65–60–65–65	64	Greenish yellow
F. coeruleum I–II	60–65–70–65	65	Patches of blue-green or none
F. coeruleum 2	60–65–60	62	0
F. coeruleum 3	25–40–35–30–25	31	Blue-green patches
F. commutatum	80–80–85	82	0
F. conglutinans	65–65–60–70	65	0
F. cubense 1	85–75–85–80	81	0
F. cubense 2	70–70–75	72	0
F. culmorum 1–I	100–100–95	98	Purple-red or none
F. culmorum 1–II	75–75–80	77	0
F. culmorum 2	100–100–100	100	Purple-red
F. culmorum 3–I	90–100–80–80–80	86	Flesh and yellow or red-purple or none
F. culmorum 3–II	90–100–90–100	95	0
F. culmorum 4–I	100–100–100	100	Outer zone of pink or none
F. culmorum 4–II	90–100–95	95	Red-purple
F. culmorum 5	90–95–100–100–95	96	Light red-purple outer zone
F. culmorum 6–1	75–85–90–80	82	0
F. culmorum 6–II	90–90–90–100	92	Red-purple
F. decemcellulare	45–50–50–55	50	Purple-red or none

[4] 0 indicates total absence of pigment.

TABLE 1.—(*Continued*)

Organisms	Measurements of Rate of Growth (mm.)	Average Rate of Growth (mm.)	Color
F. dimerum	60–55–60–60	59	0
F. diversisporum	80–85–70	78	0
F. ensiforme	50–50–45–50	49	Blue-green
F. eumartii 1–I	40–35–30–35	35	Blue-green or blue-green patches
F. eumartii 1–II	40–30–35–30–60–60	42	0
F. eumartii 2–I	35–40–40–40	39	Blue-green
F. eumartii 2–II	35–40–45–40	40	0
F. eumartii 3	40–35–40–40	39	0
F. euoxysporum	80–75–70–80	76	0
F. falcatum	100–90–90–90	92	0
F. filiferum I	90–100–90	93	0
F. filiferum II	100–85–90	92	Flesh
F. flocciferum	65–65–65–70	66	0
F. fructigenum	40–35–40–40	39	Flesh
F. fructigenum maius I	45–45–50–45	46	0
F. fructigenum maius 2–I	40–45–40–45	42	Red-purple to none
F. fructigenum maius 2–II	50–40–40–45	44	Flesh
F. fructigenum maius 2–III	50–40–40–45	44	0
F. fructigenum maius 2–IV	45–40–45–45	44	0
F. fructigenum maius 2–V	40–35–35–45	39	Orange
F. fructigenum maius 2–VII	40–40–40	40	0
F. fructigenum maius 2–VIII	40–35–45	40	0
F. fructigenum maius 3–I	90–80–75–60–65	74	0
F. fructigenum maius 3–II	70–85–75–75–60	73	0
F. fructigenum maius 3–III	75–75–85	78	Flesh or none
F. gibbosum	100–100–100–90	97	0
F. graminum 1	100–100–90–90	95	0
F. graminum 2–I	90–100–90	93	0
F. graminum 2–II	90–100–85	92	0
F. herbarum 1	30–35–30–30	31	0
F. herbarum 2	70–65–75–60	67	0
F. herbarum gibberalloides I	55–75–55–55	60	0
F. herbarum gibberalloides II	65–45–50–45	51	Red-purple, or red purple zone or none
F. herbarum pirinum I	40–35–40–40	39	0
F. herbarum pirinum II	50–50–60–60	55	0
F. hyperoxysporum 1	90–85–85	87	0
F. hyperoxysporum 2	80–70–75–85	77	0
F. incarnatum I	90–90–90	90	0
F. incarnatum II	90–90–85	89	0
F. incarnatum IV	70–85–90	82	Flesh
F. incarnatum V	90–90–85	89	0
F. javanicum 1	55–60–60–65	60	0
F. javanicum 2	75–100–90–80–80	85	0
F. lini	65–60–60–70	64	0
F. lateritium I	40–30–40	37	0
F. lateritium II	50–60–60	57	0
F. lolii	50–45–50–45	47	0
F. longheceras	85–85–85–85	85	0
F. longheceras microsporum	80–85–75–75	79	0
F. longipes	80–85–90–85	85	0

TABLE 1.—(*Continued*)

Organisms	Measurements of Rate of Growth (mm.)	Average Rate of Growth (mm.)	Color
F. lutulatum I	75–75–80–70	75	0
F. lutulatum II	75–75–80–65	74	0
F. lycopersici 1	75–75–70–85	76	0
F. lycopersici 2	80–85–85–80	82	0
F. malli	100–80–75–90	86	0
F. macroceras	100–90–90	93	Red-purple
F. martii 1	60–65–60–70	64	0
F. martii 2	90–85–85–90	87	0
F. martii 3–I	55–60–60–65	60	0
F. martii 3–II	55–60–60–65	60	Blue-green or none
F. martii minus	60–65–65–70–75	67	0
F. martii phaseoli 1–I	35–35–30–30–35	33	Blue-green or none
F. martii phaseoli 1–II	35–30–30–65–65–60	47	0
F. martii phaseoli 1–III	35–30–35–35–35	34	0
F. martii phaseoli 2–I	30–35–35–35	34	Blue-green or none
F. martii phaseoli 2–II	30–40–35–35	35	0
F. martii pisi	55–80–80–80	74	0
F. martii viride	60–75–70–70	69	0
F. moniliforme 1	85–80–80–75	80	Flesh
F. moniliforme 2	70–65–70–80	71	0
F. moniliforme 3	25–30–30–35–35	31	0
F. moniliforme 4	75–75–70–75	74	0
F. moniliforme 5	75–80–70–65	72	0
F. moniliforme erumpens I	70–50–60–70–60	62	0
F. moniliforme erumpens II	80–70–75–65–70	72	Blue-green band or none
F. moniliforme minus	75–75–80–85	79	0
F. moniliforme subglutinans	65–60–65–75	66	0
F. neoceras	55–60–55–55	56	Purple or none
F. niveum 1	75–70–75	73	0
F. niveum 2	80–90–75–85	82	0
F. orthoceras	80–80–85–80	81	0
F. orthoceras triseptatum	100–80–80–85	86	0
F. ossicolum 1	75–90–85–95	86	0
F. ossicolum 2	85–100–90–100–100	95	0
F. oxysporum 1	80–90–90–90	87	0
F. oxysporum 2	100–85–80–90	89	0
F. oxysporum nicotianae	85–80–80–85	82	0
F. paspalicola	65–65–65	65	0
F. pirinum	65–85–80–70	75	0
F. poae I	50–50–60–50	52	Red-purple
F. poae II	50–80–75–85	72	0
F. polymorphum	60–65–60–55	60	Flesh
F. pusillum	70–70–65–70–65	68	Blue-green patches or none
F. radicicola	60–70–70–75	69	0
F. rhizochromatistes	80–85–85–90	85	0
F. rhizochromatistes microsclerotium	80–85–85–85	84	0
F. sambucinum 1	40–40–40–35	39	Flesh
F. sambucinum 2	100–100–100	100	0
F. scirpi	85–80–85–80	83	0

TABLE 1.—(*Continued*)

Organisms	Measurements of Rate of Growth (mm.)	Average Rate of Growth (mm.)	Color
F. sclerostromaton	80–80–80–80	80	0
F. semitectum 1–I	50–65–75–70–65	65	Orange
F. semitectum 1–II	75–80–60–65–70	70	0
F. semitectum 1–III	75–70–65–70–65	69	Flesh
F. semitectum 1–IV	70–65–75–65–65	68	Orange-pink
F. semitectum 1–V	80–70–75–90–65	76	0
F. semitectum 1–VI	80–70–75–90–55–60	71	0
F. semitectum 1–VII	80–75–70–70–65	72	Orange or none
F. semitectum 1–VIII	90–80–85–90–80	85	0
F. semitectum 1–IX	70–70–65–60–60	65	Orange
F. semitectum 1–X	100–100–90–90–90	94	0
F. semitectum 1–XI	75–70–65–60–60	66	0
F. semitectum 1–XII	90–80–65–60–60	71	Flesh
F. semitectum 1–XIII	80–70–60–55–55	64	0
F. semitectum 1–XIV	90–85–80–70–70	79	0
F. semitectum 1–XV	80–75–80–65–65	73	0
F. semitectum 1–XVI	75–70–70–60–60	67	0
F. semitectum 1–XVII	100–90–100–85–90	93	0
F. semitectum 1–XVIII	90–100–100–90–90	94	0
F. semitectum 2	75–65–70–80	72	Pink
F. solani 1	65–70–75–80	72	0
F. solani 2–I	90–90–85–90–85	88	0
F. solani 2–II	85–70–65–70	72	0
F. solani 3–I	50–60–60–60	57	Blue-green zones or patches
F. solani 3–II	60–60–60–60	60	0
F. solani 3–III	55–60–60–65	60	0
F. solani 4–I	55–60–60–60	59	0
F. solani 4–II	55–60–60–60	59	Blue-green or none
F. solani minus 1–I	55–60–70–65–70	64	Occasional lines of blue-green
F. solani minus 1–II	60–75–60–65–70	66	0
F. solani minus 2–I	60–65–60–60	61	0
F. solani minus 2–II	65–65–60–65	64	0
F. solani soffuscum	65–60–60–65	62	Pale greenish-yellow
F. spinaceae 1	75–75–80–75	76	0
F. spinaceae 2	70–75–70–70	71	0
F. striatum 1–I	60–65–65–70	65	0
F. striatum 1–II	60–60–65–70	65	Blue-green
F. striatum 2	60–65–60–65	62	Patches of blue-green
F. striatum 3–I	60–60–60–65	61	Blue-green patches
F. striatum 3–II	65–65–60	63	0
F. sulphureum 1	90–90–100–100	95	0
F. sulphureum 2	65–75–65	68	0
F. sulphureum 3	80–85–85	83	0
F. theobrome	60–70–70–65	66	0
F. tracheiphilum	75–80–80	78	0
F. trichothecioides 1	85–60–75–70–65	71	0
F. trichothecioides 2–I	80–85–80–85–75	81	0
F. trichothecioides 2–II	70–85–85–80–85	81	Orange
F. trichothecioides 2–III	80–75–80–60	74	0
F. trichothecioides 3–I	85–85–90	87	0

TABLE 1.—(*Continued*)

Organisms	Measurements of Rate of Growth (mm.)	Average Rate of Growth (mm.)	Color
F. trichothecioides 3–II	50–40–70–75–75	62	0
F. trichothecioides 4–I	70–90–70–80	77	Light brown or none
F. trichothecioides 4–II	70–90–85–90	84	0
F. trichothecioides 5	85–80–80–75	80	0
F. trichothecioides 6	80–90–85	85	0
F. trichothecioides 7–I	60–65–60–60–65	62	0
F. trichothecioides 7–II	60–50–55–65–65	59	0
F. tricinctum 1–II	75–75–70–60	70	Red-purple patches
F. tricinctum 1–III	80–75–65–60	70	Purple-red
F. tricinctum 1–IV	55–70–60–75–60	64	0
F. tricinctum 1–V	85–60–75–65	71	0
F. tricinctum 1–VI	70–60–60–60	62	0
F. tricinctum 1–VII	75–70–80–40–65	66	0
F. tricinctum 1–VIII	60–75–50–60–60–65	61	0
F. tricinctum 1–IX	50–65–30–45	66	Pink outer zone
F. tricinctum 2	30–30–30–45	34	0
F. uncinatum	65–60–70–80–70	69	0
F. urticearum I	60–60–60–55	59	Orange
F. urticearum II	50–50–50–40	47	0
F. vasinfectum	70–70–60–55–65	64	0
F. viride 1	65–70–70–70	69	Blue-green patches
F. viride 2	65–90–80–85–90	82	0
F. viticola	55–70–55–65–70	63	Flesh
F. zonatum 1	80–80–75–80	79	0
F. zonatum 2	85–85–80–85	84	0
F. zonatum 3	85–85–90–90	86	0

resistant to the needle, and other minor details were found too untrustworthy to be included in any of the tables.

Rate of growth has always been considered a dependable specific character; yet, the foregoing table reveals a number of exceptions. *Fusarium acuminatum* 2–V averages only 62 millimeters in diameter, while the average for no. 2–I is 100 mm. *F. coeruleum* 3 measures only 31 mm., while *F. coeruleum* 1–II grows more than twice as fast. While *F. fructigenum maius* 1 and all the variants of no. 2 are comparatively slow-growing organisms, all three strains of *F. fructigenum maius* 3 grow nearly twice as fast. *F. herbarum* 1 forms a colony with a diameter of only 31 mm., while no. 2 averages 67 millimeters. *F. lateritium* I is a slow grower and no. II is a comparatively fast grower. *F. moniliforme* 3 is the only slow grower of all the strains of this species. The strains of *F. semitectum* vary from 64 to 94 millimeters, thus precluding the possibility of forming any common meeting ground for the individuals of this species. All strains of *F. eumartii* are slow growers, averaging between 35 and 40 mm. However, *F. eumartii* 1–II, after behaving like the others for a while, suddenly jumped to 60 mm. *F. martii phaseoli* 1–II has shown a similar behavior and after averag-

ing no more than 30–35 millimeters in six days, it suddenly began to measure 60–65 mm. Some of the variants of *F. semitectum* 1 also have exhibited from time to time similar sudden acceleration of growth. The possibility of contamination as a factor in such behavior does not hold because such fluctuations are reversible. Furthermore, all other characteristics of such erratic organisms have remained singularly stable, in so far as the average for the species is concerned.

PIGMENT FORMATION

Five nutrient agars have been used in order to obtain a more comprehensive range of color production and pigment fluctuation among Fusarium cultures. Of these the first three are prepared from standardized products, while the last two (steamed rice and oatmeal agar) are included to satisfy those who have been in the habit of considering complex vegetable media as the more "natural" substrata. The following formulae give the preparation of these nutrient agars:

1. *Malt extract agar.*—(Formula on page 14.)
2. *Synthetic agar.*—

Potassium nitrate	2 g.
Dihydrogen potassium phosphate	1 g.
Magnesium sulfate	1 g.
Levulose	30 g.
Agar-agar	20 g.
Distilled water	1,000 c.c.

3. *Proteose-peptone agar.*—

Proteose peptone	5 g.
Dihydrogen potassium phosphate	1 g.
Magnesium sulfate	1 g.
Maltose	20 g.
Agar-agar	20 g.
Distilled water	1,000 c.c.

4. *Steamed rice.*—
   2.5 grams of polished rice and 5 c.c. of distilled water were placed in each test-tube and autoclaved at 15 pounds for 15 minutes.
5. *Oatmeal agar.*—
   Prepared the usual way, except that only 50 grams of oatmeal was used for each 1,000 c.c. of water.

Readings were made one month after inoculation and, as far as possible, the range of variation is given in table 2, although nothing but general terms have been used in color differentiation.

Inconstancy of color production is very evident in the foregoing table. For example, *F. acuminatum* 1–I and 1–VIII, *F. asclerotium*, *F. aurantiacum*, *F. batatatis* 2, *F. culmorum* 1–I and 1–II, *F. fructigenum maius* 1–I

TABLE 2.—*Color production on malt extract, potassium nitrate, peptone and oatmeal agars, and on steamed rice (one month at 25° C.)*[5]

Organism	Malt extract agar	Potassium nitrate agar	Peptone agar	Steamed rice	Oatmeal agar
F. acuminatum 1	0	0	0	0	0
F. acumination 2–I	0–red	Red	Red	Yellow and brown	Red
F. acuminatum 2–II	0–orange	Orange and red	Red-yellow	Yellow and brown	Red or faint purple
F. acuminatum 2–III	0–red	Orange and red	Red-orange	Yellow and light purple	Reddish purple
F. acuminatum 2–IV	Red	Red	Red	Yellow and purple brown	Red
F. acuminatum 2–V	0	0	0	Yellow	0–faint pink
F. acuminatum 2–VI	0	0–trace of red	0–trace purple	Orange or faint purple	0–faint pink
F. acuminatum 2–VII	0	0	0	Tan–trace of purple	0–faint pink
F. acuminatum 2–VIII	Orange–faint red	0–red	0–red	Red or orange	Red
F. alluviale	0	0	0	0–pink	0
F. anthophilum	0	0–yellow	Orange	Orange	Orange
F. aquaeductuum pusilum	Flesh	Flesh	Flesh	Cream	Cream
F. aquaeductuum volutum	0	0	0	Orange	Cream
F. arcuatum	0–blue green patch	Yellow–trace of blue green	Blue green	Yellow or pink and yellow	Greenish yellow
F. asclerotium	0	0–light purple	0–light purple	0–reddish purple	Purplish gray
F. aurantiacum	0	0–lavender	0–faint purple	Purple	Purple
F. batatatis 1	0	0	0	0	0
F. batatatis 2	0	0–light purple	0	Pink	Light purple
F. bulbigenum	0	0	0	Light purple	Purple patches
F. bullatum I	0	0	0	Salmon or faint purple	Brownish yellow
F. bullatum II	0	0	0	Brown	Orange
F. bullatum brevius	0	0	0	Brown–trace of salmon	Flesh
F. camptoceras I	0–brown	Light brown	Light brown	Brown	Tan or purplish brown
F. camptoceras II	Light brown	Light brown	Light brown	Brown	Tan or trace of red
F. caudatum	0	0	0	0	0
F. chlamydosporum I	Brown	Brown	Tan–reddish purple	Light brown	Brown–trace of red

[5] 0 indicates absence of pigment.

TABLE 2.— (*Continued*)

Organism	Malt extract agar	Potassium nitrate agar	Peptone agar	Steamed rice	Oatmeal agar
F. chlamydosporum II	Orange	Brown and salmon	Tan-orange	Brown and salmon	Purplish brown and salmon
F. chlamydosporum III	Brown	Brown-orange	0–brown and faint purple	Light brown and faint purple	Brown–trace of red
F. chenopodinum	0	0	0	0	0
F. coeruleum 1–I	Blue-green	0–blue-green patches	0–blue-green	Pink and brown	Blue-green
F. coeruleum 1–II	0–streaks of blue-green	0–blue-green patches	Pink	Pink	0–purple
F. coeruleum 2	0	0	0	Faint pink	0–faint pink and blue-green
F. coeruleum 3	Blue-green	Light purple–trace blue-green	Blue-green	Pink	Purple–blue-green
F. commutatum	0	0	0	0–orange	0–patches of pink and orange
F. conglutinans	0	0	0	Faint purple	0
F. cubense 1	0	0–faint purple	0–light purple	0–trace of purple	Light purple
F. cubense 2	0	0–faint purple	Light purple	Reddish purple	Purple
F. culmorum 1–I	0–red	Red	Red	Gold and trace of purple	Red
F. culmorum 1–II	0	0–red and orange	0–reddish purple	Yellow and orange	Orange with red patches
F. culmorum 2	Red	Red and orange	Red	Purplish red and orange	Red and yellow
F. culmorum 3–I	Reddish purple	Red and orange	Red and orange	Gold and pink	Red
F. culmorum 3–II	0–orange	0	0	0	0
F. culmorum 4–I	Brown or red	Red and orange	Red and orange	Yellow to faint pink or purple	Red and brownish yellow
F. culmorum 4–II	Reddish purple	Red	Red	Gold and pinkish brown	Red-orange and red
F. culmorum 5	0–purple	Red and orange	Red and orange	0–yellow and trace of red	Red
F. culmorum 6–I	0	0–faint purple	0	Light purple	0–faint purple
F. culmorum 6–II	Purplish red	Crimson	Red	Yellow and pink	Red-gold and red
F. decemcellulare	0–crimson	Crimson and orange	Red	Gold or red and yellow	Red and gold
F. dimerum	0	0	0	0	0
F. diversisporum	0	0	0	0	0
F. ensiforme	Blue-green	Blue-green	Blue-green	Purplish brown	Purple

TABLE 2.— (Continued)

Organism	Malt extract agar	Potassium nitrate agar	Peptone agar	Steamed rice	Oatmeal agar
F. eumartii 1–I	Blue-green	0–blue-green patches	Blue-green	Faint pink	0
F. eumartii 1–II	0	0	0	Pink and brown	Blue-green and pink
F. eumartii 2–I	0–blue-green	Grayish blue patch	0–blue-green	0–light purple	0
F. eumartii 2–II	0	0	0–blue-green	Pink	0
F. eumartii 3	0	0	0	Purple	Light purple
F. euoxysporum	0–light purple patch	Faint purple	0	0–flesh	0–light brown
F. falcatum	0	0	0	Brown-purple	Brownish yellow
F. filiferum I	0–light brown	Brown	Light brown	0–brown and pink	0–orange
F. filiferum II	0–orange	0–orange	0	Purple	0–faint purple
F. flocciferum	0	0	0	Patches of yellow	Light yellow
F. fructigenum	0	0	0	Purplish red	Purple
F. fructigenum maius I	0	0	0	0	0
F. fructigenum maius 2–I	0–red	0–red	0	0	0–trace of red
F. fructigenum maius 2–II	0–orange	0–red	0–red patch	Yellow–faint pink	Yellow–trace of red
F. fructigenum maius 2–III	0	0	0	0	0
F. fructigenum maius 2–IV	0	0	0	0	0
F. fructigenum maius 2–V	0–orange	Orange	Orange–patch of blue-green	Salmon–light purple	0–orange
F. fructigenum maius 2–VII	0	0	0	0	0
F. fructigenum maius 2–VIII	0	0	0	0	0
F. fructigenum maius 3–I	0	0	0	Orange	0
F. fructigenum maius 3–II	0	0	0	Orange	0
F. fructigenum maius 3–III	0–orange	0–orange	0	Red–brownish purple	Faint pink
F. graminum 1	0	0	0	0	0
F. graminum 2–I	0	0	0	Brown and flesh	0–patch of red
F. graminum 2–II	0	0	0	Brown and flesh	0–patch of pink

TABLE 2.— (Continued)

Organism	Malt extract agar	Potassium nitrate agar	Peptone agar	Steamed rice	Oatmeal agar
F. herbarum 1	Purple-red zone	Red–trace of pink	Pink–trace of red	Gold	Red and gold
F. herbarum 2	0	0	0	0–yellow and faint pink	0
F. herbarum gibberalloides I	0	0	0	0	0
F. herbarum gibberalloides II	Red	Red-gold and red	Red	Gold and brown	Gold and red
F. herbarum pirinum I	0	0	0	0	0
F. herbarum pirinum II	0	0	0	0	0
F. hyperoxysporum I	0	0–purple	0	Faint purple	Purple
F. hyperoxysporum 2	0	0	0–trace of purple	Light purple	0–orange
F. incarnatum I	0	0	0	0–flesh	0–orange
F. incarnatum II	0	0	0	0–faint purple	0
F. incarnatum IV	0	0	0	0–salmon	0–orange
F. incarnatum V	0	0	0	0–salmon	0–yellow
F. javanicum 1	0	0	0	0	0
F. javanicum 2	0	0–purple	0–purple	Reddish purple	Purple
F. lateritium I	0	0	0	0–light purple	0
F. lateritium II	0	0	0	0	0
F. lini	0	0–lavender	0	Light purple and pink	0–faint purple
F. lolii	0	0	0	0	0
F. loncheceras	0	0–mauve	0	Light purple	Purple
F. loncheceras microsporum	0	Purple	0–purple	Light purple	Purple
F. longipes	0	0	0	0	0
F. lutulatum I	Tan–blue-green streaks	Orange–blue-green	Orange–blue-green	Yellow	Tan and purple patch
F. lutulatum II	Tan–blue-green streaks	Tan–patch of blue-green	Tan–blue-green	0	0
F. lycopersici 1	0	0	0–purple	Pink	Faint purple
F. lycopersici 2	0	0	0	0	0
F. malli	0	0	Bluish gray	Pink	0–purple
F. macroceras	Red	Red and orange	Red and orange	Gold and trace of salmon	Red
F. martii 1	0–blue-green patch	Tan–blue-green patch	Faint bluish gray–brown	Pink and brown	Yellow and faint purple
F. martii 2	0	0–faint purple	Purple–faint purple	Crimson	0–red

TABLE 2.— (Continued)

Organism	Malt extract agar	Potassium nitrate agar	Peptone agar	Steamed rice	Oatmeal agar
F. martii 3–I	0	0	0	0–light purple	0
F. martii 3–II	0–blue-green	0	0	Light purple	0
F. martii minus	0	0	0–trace of blue-green	0–faint purple	0
F. martii phaseoli 1–I	Blue-green	Blue-green	Blue-green	Pink and light purple	Blue-green–pink
F. martii phaseoli 1–II	0	0	0	0–faint purple	0
F. martii phaseoli 1–III	0–blue-green patch	Light purple	Blue-green–pink	Pink	0-patches of blue-green and pink
F. martii phaseoli 2–I	0–blue-green	Blue-green	Blue-green	Pink and purple	Blue-green and pink
F. martii phaseoli 2–II	0	0	0	0–pink	0
F. martii pisi	0	0	0	0	0
F. martii viride	0	0–blue-green	0–blue-green	0–light purple	0–yellow patch
F. moniliforme 1	0	0–patches of blue	0–patches of blue-green or purple	Reddish purple patch	Purplish gray
F. moniliforme 2	0	0	0	0	0
F. moniliforme 3	0	0	0	Orange	0
F. moniliforme 4	0–blue-green patch	Purple–blue-green	0–blue-green patch	Purple and red	Purple
F. moniliforme 5	0	0–purple	0	Light purple	Purple
F. moniliforme erumpens I	0	Faint purple-blue-green	Faint purple-blue green	Trace of purple	Purple and red
F. moniliforme erumpens II	0	Faint purple-blue-green	Faint-purple-blue green	Pink	Purplish gray
F. moniliforme minus	0	Purple–faint blue zone	Purple-blue-green	Reddish purple	Purple
F. moniliforme subglutinans	0–blue-green patch	0–purple	Purple-patch of blue-green	Pink	Purple
F. neoceras	0–lavender	Deep purple	Purple	Deep reddish purple	Deep violet blue
F. niveum 1	0	0–faint purple	Faint purple-patch of blue-green	Red and purple	Light purple
F. niveum 2	0	0–faint purple	Red-purple	Red and purple	Purple-patches of purple
F. orthoceras	0	0–lavender	0–light purple	Reddish purple	Purple
F. orthoceras trisepta-tum	0	0–purple	0–light purple	Faint purple-red	Purple
F. ossicolum 1	0	Greenish-yellow	0	Tan and faint pink	0–brownish yellow
F. ossicolum 2	0	0	0	Tan-brown	0–tan
F. oxysporum 1	0	0–light purple	0–purple	Purplish red	Purple
F. oxysporum 2	0–lavender patch	0–purple	0–pink	Pink	Light purple

TABLE 2.— (*Continued*)

Organism	Malt extract agar	Potassium nitrate agar	Peptone agar	Steamed rice	Oatmeal agar
F. oxysporum nicotianae	0	0	0	Pink	0–lavender
F. paspalicola	0–faint purple	0–trace of purple	Pink	0	0
F. pirinum	0	0	0	Orange	Yellow
F. poae I	Reddish purple	Red	Red–red and gold	Gold–gold and red	0–red
F. poae II	0–reddish purple zone	0–patches of red	0–red and gold	Yellow-gold and red	Gold and red
F. polymorphum	0	0	0	0–faint pink and yellow	0–red
F. pusillum	0	0	0	Pink	0
F. radicicola	0	0	0–patch of blue-green	0–faint purple	0
F. rhizochromatistes	0	Light purple	0–light purple	Purple	Purple
F. rhizochromatistes-micorsclerotium	0	Purple	0–purple	Purple	Purple
F. sambucinum 1	Red	Red	Red	Yellow	Red and yellow
F. sambucinum 2	0	Pinkish brown	0–brown	Orange	Brown
F. scirpi	0	0	0	0	0
F. sclerostromaton	0	Purple	0–purple	Reddish purple	Purple
F. semitectum 1–I	Orange	Orange-salmon	Salmon	Brown and salmon	Salmon
F. semitectum 1–II	0–orange	Tan	Salmon	Salmon	Orange
F. semitectum 1–III	0	0	0	0	0
F. semitectum 1–IV	Salmon pink	Salmon	Salmon	Brown and salmon	Salmon
F. semitectum 1–V	0–salmon	Tan	0–orange	Yellow and salmon	0
F. semitectum 1–VI	0	0	0	0–orange	0
F. semitectum 1–VII	0–salmon	0–salmon	Salmon	Salmon and brown	Salmon
F. semitectum 1–VIII	0	Faint purple	0–light purple	Light purple	Purple patch
F. semitectum 1–IX	Salmon	0–salmon	Salmon	Salmon	0–salmon
F. semitectum 1–X	0–salmon	Tan	Salmon	Brown and salmon	Brown
F. semitectum 1–XI	0	0	0	0–salmon	0
F. semitectum 1–XII	0–salmon	Salmon	Salmon	Salmon	Orange
F. semitectum 1–XIII	0–salmon	0	0	Salmon and brown	0–light orange
F. semitectum 1–XIV	0–light brown	0	0–light salmon	Salmon and yellow	0–light orange

TABLE 2.—(*Continued*)

Organism	Malt extract agar	Potassium nitrate agar	Peptone agar	Steamed rice	Oatmeal agar
F. semitectum 1–XV	0–orange	0–salmon	Salmon	Salmon	0–light orange
F. semitectum 1–XVI	0–salmon	Salmon	Salmon	Salmon and brown	0–flesh
F. semitectum 1–XVII	0–light brown	Tan	Tan-orange	Salmon and brown	Light brown and pink
F. semitectum 1–XVIII	0–orange	Tan	Salmon	Salmon and brown	Yellowish brown
F. semitectum 2	Light salmon	Brown and salmon	Brown and salmon	Brown and salmon	0–pink
F. solani 1	0	0	0	Pink	0
F. solani 2–I	0	0	0–purple	Pink	Light purple
F. solani 2–II	0–bluish gray	0–blue-green	0–bluish gray	Faint purple	0
F. solani 3–I	Blue-green patch	Blue-green patch-faint purple	0–blue-green patch	0–reddish purple	0–blue-green
F. solani 3–II	0–blue-green patch	0	0	0	0
F. solani 3–III	0	0	0	0–faint pink	0
F. solani 4–I	0	0	0	0–faint purple	0
F. solani 4–II	0–blue-green patch	0 –blue-green and purple patch	0–blue-green patch	Flesh-pink	Trace of blue-green
F. solani minus 1–I	0	0	0	0–pink and light brown	0–tan
F. solani minus 1–II	0	0	0	0–pink	0
F. solani minus 2–I	0–blue-green	0	0–bluish green	Pink or purple	0–brown
F. solani minus 2–II	0	0	0	0	0
F. solani suffuscum	0	0–trace of blue-green	0–red	Orange-pink	0–orange
F. spinaceae 1	0	0	0	Trace of purple	0–faint purple or blue-green
F. spinaceae 2	0	0	0–trace of purple	Purplish red	0–faint purplish gray
F. striatum 1–I	0	0	0	0	0
F. striatum 1–II	Dark blue-green	Brownish purple	Brownish purple	Purple-brown	Purple and pink
F. striatum 2	Blue-green patch	0	0–blue-green	Orange	0–greenish brown
F. striatum 3–I	0–faint blue-green	Yellow	Yellow	Red-purple	Light brown
F. striatum 3–II	0	0–yellow	0–yellow	0–faint purple	0–light brown
F. sulphureum 1	0	0	0	0	0
F. sulphureum 2	0–blue-green zone	0–pink and yellow	0–yellow and orange	Yellow	Yellow-red-purple
F. sulphureum 3	0–orange	Pale orange	Orange	Salmon	Orange

TABLE 2.—(*Continued*)

TABLE 2.—(*Continued*)

Organism	Malt extract agar	Potassium nitrate agar	Peptone agar	Steamed rice	Oatmeal agar
F. theobrome	0	0	0	0	0
F. tracheiphilum	0	0	0	0	0–faint purple patch
F. trichothecioides 1	0	0	0	0–pink	0
F. trichothecioides 2–I	0	0	0	Orange and salmon	0
F. trichothecioides 2–II	0–orange	Orange	0–orange	Salmon	Orange
F. trichothecioides 2–III	0	0	0	Salmon	0
F. trichothecioides 3–I	0	0	0	0	0
F. trichothecioides 3–II	0	0	0	0	0
F. trichothecioides 4–I	0	0	0	Yellow and salmon	0
F. trichothecioides 4–II	0	0	0	0–light brown and faint purple	0–pink
F. trichothecioides 5	0	0–purple	0–purple	Blue and trace of red	Purple
F. trichothecioides 6	0	Faint purple	0–blue-green	Red	Light purple
F. trichothecioides 7–I	0	0	0	0–light purple	0
F. trichothecioides 7–II	0	0	0	0	0
F. tricinctum 1–II	Purplish red	Red and yellow	0–yellow	Orange-tan	Reddish purple
F. tricinctum 1–III	Purplish red	Red and orange	Purplish red patch	Tan-flesh	Reddish purple-yellow
F. tricinctum 1–IV	0–purplish red	Red and orange	Purplish red patch	Flesh-gold	Reddish purple-yellow
F. tricinctum 1–V	0	0–red and orange	Purplish red patch	0–tan and pink	Reddish purple-yellow
F. tricinctum 1–VI	0–red zone	Red and yellow	Red and yellow patch	Tan-faint pink	Reddish purple-yellow
F. tricinctum 1–VII	Purplish red patch	Crimson-orange and red	Crimson	Crimson-tan	Crimson
F. tricinctum 1–VIII	Purplish red	0–red	0–red patch	0–tan	Reddish purple patch
F. tricinctum 1–IX	Purplish red	Red and orange	Patch of red and blue-green	Tan-reddish purple	Reddish purple-yellow
F. tricinctum 2	0–red patch	Red-pink patch	Orange with purple patch	Orange	Red
F. uncinatum	0–orange	Yellow	0–orange and blue-green patch	Yellow	Orange–faint purple
F. urticearum I	0	0	0	0	0
F. urticearum II	0	0	0	0	0
F. vasinfectum	0	0–faint purple	0–purple	Pink	Purple
F. viride 1	0–bluish gray	0–trace of purple	0–bluish gray patch	Brownish purple-pink	0–purplish gray
F. viride 2	0	0–trace of purple	0	Trace of pink	0–purple
F. viticola	Reddish purple patch	Red-pink and orange	0	Yellow	Reddish purple and orange
F. zonatum 1	0	0	0	0	0–lines of reddish purple
F. zonatum 2	0	0	0	0	0
F. zonatum 3	0	0	0	0–faint pink	0–pink

and 1–II, *F. hyperoxysporum* 1, *F. javanicum* 2, *F. lini*, *F. loncheceras*, *F. moniliforme* 5, *F. moniliforme subglutinans*, *F. orthoceras*, *F. orthoceras triseptatum*, *F. oxysporum* 1 and 2, *F. solani* 2–II, *F. trichothecioides* 5, *F. tricinctum* 1–V and 1–VIII, and many others may at one time appear in bright colors, and then, on subsequent trials, grow without the production of the faintest pigment. Nor is this confined to the purely synthetic agar. All of the remaining media exhibit similar phenomena in a more or less striking degree. Many of these cultures have been repeated sufficiently to prove that such fluctuations are inherent in the protoplasm rather than the result of faulty technique or accidental contamination.

The different strains of the same species and the different variants of the same strain are not, necessarily, very similar in their color production. Even after the elimination of the less bright shades, such as flesh, salmon, and yellow, also such pigments as manifest themselves in patches, lines, or irregular spots, there will still be a large number of departures from the specific path. The following are examples of such cases occurring on malt-extract agar. *Fusarium acuminatum* 1 is colorless; so are 2–V, 2–VI and 2–VII; 2–I and 2–III are sometimes colorless and sometimes red, while 2–IV is always red. *F. coeruleum* 1–I and 3 are blue-green, 1–II sometimes colorless and sometimes showing blue-green, while no. 2 is always colorless. *F. culmorum* 1–I is usually bright red with golden aerial hyphae, although occasionally it may appear colorless; 1–II is usually colorless, but sometimes shows the red and gold. The remaining strains of this species show all sorts of variation, such as crimson, purplish red, orange, or, as in case of 6–I, may be always colorless. Two strains of *F. eumartii* may produce blue-green pigment, but the remaining three are always colorless. *F. fructigenum maius* 2–I has been extremely erratic; at one time it has repeatedly produced a bright red pigment, and at other times it has failed to form any color. Such periods have alternated in the life of this organism, and all attempts to control them have been futile. *F. herbarum* 1 has appeared in purple or red color, *F. herbarum* 2 has formed no pigment. Similarly, *F. herbarum giberalloides* I seems unable to produce pigment, whereas no. II has been a dazzling red with beautiful patterns along the outer edges of the colony. *F. striatum* 1–I is colorless and 1–II dark blue green, becoming black with age.

Similar variations are to be found on the other media, demonstrating that such variations are not peculiar to a given agar. Of the complex vegetable media, the steamed rice is less conducive to color differentiation and spore production than oatmeal agar. It seems that too many organisms tend to develop some shade of pigment on steamed rice and thus the use of this medium serves to reduce clear-cut differences between species and strains.

PRODUCTION OF SPORE MASSES ON DIFFERENT MEDIA

Only one other characteristic aside from color formation has been considered in connection with work on solid media, namely, the formation of spore masses. Since sclerotia have been extremely erratic and seem to form only when the organisms are freshly isolated from their hosts, no significance has been attached to their periodic appearance. The spore masses, however, have been fairly uniform. The writer has avoided the use of the terms sporodochia and pseudopionnotes because he feels that they are often confused by the average worker, especially when there are too many uncertain forms between the borderlines of these two types of fruiting structures. The spore mass is used here merely to designate any gelatinous exudation of spores which can be seen and differentiated with the unaided eye. This practice may seem a bit unorthodox, but is, nevertheless, extremely convenient.

The readings were made one month after inoculations. The temperature, in all cases, was 25° C. It is probable that if temperature, length of growing period, and the quality and quantity of the nutrient agars were altered, the results would be quite different. However, it is not the purpose of this work to make definite statements concerning the ability of these Fusaria to show positive or negative reactions under all conditions. All the results here tabulated concern themselves with the immediate environmental factors under which they were produced, and their proper interpretation should be confined to the experimental limits that are outlined here.

To conserve space, only those organisms which gave positive results have been included in the table following.

Oatmeal agar induces the formation of spore masses in more organisms than the other three, although the difference is small. The significant part, however, is not the comparative efficiency of different media in this respect, but the fact that the strains of the same species, and even the variants of the same strain, all coming from a single spore, should show such sharp differences in their ability to form spore masses. When the results obtained with oatmeal agar are examined, it can be seen that *F. bullatum* I produces no spore masses, while *F. bullatum* II does; *F. coeruleum* 1–I has spore masses and *F. coeruleum* 1–II, 2 and 3 do not; *F. filiferum* I gives negative results and *F. filiferum* II gives positive results; *F. herbarum gibberalloides* I appears without spore masses, while II appears with plenty of them; *F. incarnatum* IV does possess them, *F. incarnatum* I, II and V do not; of the three variants of *F. martii phaseoli* 1 only one has spore masses, and only *F. martii phaseoli* 2–I can produce these gelatinous guttations. Only three of the eighteen variants of *F. semitectum* 1 have them, and only two of all the forms of *F. trichothecioides* give positive results in

TABLE 3.—*Production of spore masses on different nutrient agars (1 month at 25° C.)*[6]

Organism	Oatmeal Agar Relative Quantity and Color of Spore Masses		Synthetic Agar Relative Quantity and Color of Spore Masses		Malt Extract Agar Relative Quantity and Color of Spore Masses		Peptone Agar Relative Quantity and Color of Spore Masses	
F. anthophilum	IV	Orange	III	Orange	0	0	0	0
F. bullatum II	III	Orange	II	Orange	IV	Orange	II	Orange
F. bullatum brevis	III	Orange	0	0	0	0	0	0
F. coeruleum 1–I	V	Gray	V	Blue-green & cream	III	Bluish gray	V	Blue-green
F. culmorum 4–II	IV	Brown	III	Brown	IV	Orange	IV	Brown
F. decemcellulare	II	Cream	0	0	II	Orange	0	0
F. eumartii 1–I	0	0	V	Blue-green	IV	Blue	III	Blue-green
F. eumartii 2–I	II	Gray	IV	Gray	IV	Blue	V	Blue-green
F. eumartii 2–II	II	Cream	II	Cream	0	0	III	Cream
F. eumartii 3	II	Cream	0	0	0	0	0	0
F. filiferum II	IV	Orange	V	Orange	III	Orange	IV	Orange
F. flocciferum	III	Cream	II	Gray	0	0	IV	Cream & blue-green
F. fructigenum maius 1	II	Orange	0	0	0	0	0	0
F. fructigenum maius 2–I	III	Orange	II	Orange	IV	Orange	0	0
F. fructigenum maius 2–II	II	Orange	III	Orange	IV	Orange	0	0
F. fructigenum maius 2–V	III	Orange	V	Orange	V	Orange	V	Orange
F. fructigenum maius 3–III	V	Brown	0	0	III	Orange	0	0
F. herbarum gibberalloides II	IV	Orange	III	Orange	III	Orange	III	Orange
F. incarnatum III	0	0	V	Orange	0	0	0	0
F. incarnatum IV	III	Orange	0	0	IV	Orange	0	0
F. lutulatum I	V	Cream	V	Orange	V	Cream	IV	Blue
F. lutulatum II	III	Cream	III	Cream	0	0	II	Cream
F. macroceras	0	0	III	Orange	V	Orange	IV	Orange
F. martii 1	II	Cream	II	Cream	II	Orange	0	0
F. martii phaseoli 1–I	IV	Blue-green	III	Blue-green	IV	Blue	III	Blue-green
F. martii phaseoli 2–I	III	Blue-green	IV	Blue-green	IV	Blue	IV	Blue-green
F. martii pisi	II	Cream	0	0	0	0	III	Cream
F. martii viride	0	0	0	0	0	0	III	Orange
F. moniliforme erumpens II	0	0	IV	Orange	0	0	V	Orange
F. ossicolum 1	0	0	0	0	II	Orange	0	0
F. ossicolum 2	IV	Cream	V	Cream	0	0	V	Cream
F. radicicola	III	Cream	III	Gray	0	0	III	Gray

[6] Symbol I signifies very slight; V, very abundant; the remaining symbols indicate the proportional abundance of the spore masses.

TABLE 3.—(*Continued*)

Organism	Oatmeal Agar Relative Quantity and Color of Spore Masses		Synthetic Agar Relative Quantity and Color of Spore Masses		Malt Extract Agar Relative Quantity and Color of Spore Masses		Peptone Agar Relative Quantity and Color of Spore Masses	
F. sambucinum	IV	Orange	V	Orange	III	Orange	IV	Orange
F. semitectum X	IV	Orange	II	Orange	III	Orange	0	0
F. semitectum XIII	0	0	0	0	II	Orange	0	0
F. semitectum XVII	IV	Orange	IV	Orange	IV	Orange	0	0
F. semitectum XVIII	III	Orange	IV	Orange	IV	Orange	II	Orange
F. solani 2–I	III	Blue-green & gray	0	0	II	Gray	0	0
F. solani 2–II	IV	Cream	V	Cream	0	0	V	Blue-green
F. solani 3–I	IV	Cream	III	Gray	II	Blue-green	III	Blue-green
F. solani minus 2–I	IV	Blue-green	V	Cream & blue-green	0	0	V	Blue-green
F. solani minus 2–II	0	0	0	0	III	Gray	0	0
F. striatum 1–II	0	0	0	0	III	Gray	0	0
F. striatum 2	III	Gray	IV	Gray	0	0	V	Gray
F. striatum 3–I	0	0	III	Cream	0	0	II	Gray
F. sulphureum 2	V	Yellow	V	Yellow	IV	Cream	0	0
F. sulphureum 3	0–V	Orange	V	Orange	III	Orange	V	Orange
F. trichothecioides 2–II	IV	Orange	V	Orange	V	Orange	0	0
F. trichothecioides 4–I	0	0	0	0	III	Cream	0	0
F. trichothecioides 4–II	III	Cream	V	Light brown	III	Cream	0	0
F. tricinctum 1–III	III	Brown	III	Orange	III	Orange	0–V	Brown
F. tricinctum 1–IV	IV	Yellow and pink	III	Pink	0	0	0	0
F. tricinctum 1–IX	IV	Light brown	0	0	0	0	0	0
F. tricinctum 2	0	0	III	Cream	III	Orange	0	0
F. uncinatum	IV	Light brown	0	0	0	0	0	0
F. vasinfectum	II	Gray	0	0	0	0	0	0
F. viride 1	III	Cream	III	Cream	III	Gray	IV	Blue-green
F. viticola	IV	Orange	IV	Orange	III	Orange	V	Orange
F. zonatum 2	IV	Cream	0	0	III	Cream	V	Cream
F. zonatum 3	III	Orange	IV	Cream	IV	Orange	V	Cream

this respect. The other agars show similar and just as striking differences, and prove that these are not accidental fluctuations or contaminations but specific behavior of the individual organism regardless of its artificial affinities with sister forms.

REPRODUCTION ON MALT EXTRACT AGAR

Reproduction in Fusaria is not as dependable a criterion as other vital activities but it exhibits certain interesting modifications which may exert some influence in a proper construction of species concept. It is the chief purpose of this paper to demonstrate that the strains of the same species may often exhibit as wide variations among themselves as do the different species; therefore, even though the reproduction factor should not be given a primary rôle in a scheme of differentiation, it should, nevertheless, serve a useful purpose.

All microscopic examinations were begun one month after the transfers were made to malt-extract agar. The work was repeated at least once and sometimes twice, and it was extended over one year, so that a long period elapsed between the two trials. After the notes on the first experiment were taken, they were filed away and no reference was made to them until after the second set of notes was taken. This practice has been followed throughout the work and has been found very useful in reducing the error due to the personal equation and unconscious point-stretching to an absolute minimum. Each reading, expressed in Roman numerals, is separated from others by a dash, such as II–0–III; this means that one set of cultures yielded macroconidia the approximate amount of which was estimated as II; another set of cultures was read as 0, and another as III. This practice has been followed throughout the work.

Even a casual glance at table 4 is sufficient to show the numerous and striking variations exhibited by the different strains of the same species. *F. acuminatum* 2–IV, 2–VI, and 2–VII produce no macroconidia, while the remaining six do. *F. coeruleum* 1–I is the only strain of this species capable of forming macroconidia on malt-extract agar and number 3 is the only one unable to form microconidia. *F. culmorum* 6–I and 6–II, and perhaps number 2, form microconidia, the remaining strains do not. All except *F. eumartii* 1–I give rise to microconidia. *F. fructigenum maius* 1 and 2–VIII and 3–II produce chlamydospores but the others do not. *F. herbarum* 1 seems to be sterile, while number 2 forms both micro- and macroconidia. *F. hyperoxysporum* 1 possesses chlamydospores, while number 2 has no such spores. *F. lateritium* I has an abundance of macroconidia, but number II is sterile. *F. martii* 3–I and 3–II have no macroconidia, while numbers 1 and 2 may produce them. *F. martii phaseoli* 1–II is the only strain of this species capable of giving rise to microconidia, 1–I and 2–I are the only ones

TABLE 4.—*Reproduction on malt-extract agar (one month at 25° C.)*[7]

Organism	Microconidia	Macroconidia	Chlamydospores
F. acuminatum 1	II–0–0	II–0–V	V–V–V
F. acuminatum 2–I	0–0	IV–I	III–IV
F. acuminatum 2–II	0–0–0	0–III–I	IV–IV–V
F. acuminatum 2–III	0–0–0	0–IV–0	0–III–V
F. acuminatum 2–IV	0–0	0–0	II–III
F. acuminatum 2–V	0–I–0	0–I–0	0–III–0
F. acuminatum 2–VI	0–0	0–0	0–I
F. acuminatum 2–VII	0–0	0–0	0–I
F. acuminatum 2–VIII	0–0–0	II–III–III	0–III–II
F. alluviale	III–III	0–I	V–IV
F. anthophilum	I–0	V–IV	0–0
F. aquaeductuum pusilum	II–IV	III–IV	V–IV
F. aquaeductuum volutum	0–0	IV–IV	0–0
F. arcuatum	I–0–I	III–III–II	0–III–I
F. asclerotium	V–V–V	III–0–0	IV–V–V
F. aurantiacum	V–IV	0–I	V–IV
F. batatatis 1	III–III	II–II	V–V
F. batatatis 2	V–V	III–II	V–IV
F. bulbigenum	IV–IV	III–I	V–V
F. bullatum I	II–II	III–V	0–0
F. bullatum II	I–IV	V–IV	0–IV
F. bullatum brevius	II–0–III	V–IV–0	0–0–II
F. camptoceras I	II–II	IV–V	0–0
F. camptoceras II	II–II	IV–V	0–0
F. caudatum	III–0–II	III–III–III	III–III–III
F. chlamydosporum	0–I	0–I	V–V
F. chlamydosporum II	0–0–III–0	0–I–0–0	V–V–V–IV
F. chlamydosporum III	II–III	0–0	V–V
F. chenopodinum	III–III	II–IV	0–0
F. coeruleum 1–I	IV–IV	III–IV	IV–IV
F. coeruleum 1–II	III–II	0–0	III–III
F. coeruleum 2	IV–III–III	0–0–0	0–II–III
F. coeruleum 3	0–0	0–0	II–III
F. commutatum	III–III	0–0	0–0
F. conglutinans	III–III–II	I–0–0	II–0–IV
F. cubense 1	V–IV	III–III	V–IV
F. cubense 2	V–III	0–0	IV–IV
F. culmorum 1–I	0–0	III–II	0–0
F. culmorum 1–II	0–0	II–II	0–0
F. culmorum 2	I–0	V–V	0–0
F. culmorum 3–I	0–0	IV–III	IV–III
F. culmorum 3–II	0–0	III–IV	II–III
F. culmorum 4–I	0–0	IV–IV	IV–III
F. culmorum 4–II	0–0	V–V	IV–IV
F. culmorum 5	0–0	IV–III	IV–V
F. culmorum 6–I	IV–V–IV	0–II–0	IV–IV–IV
F. culmorum 6–II	I–I	III–III	0–0
F. decemcellulare	III–III–IV	0–V–0–V	0–0–0
F. dimerum	IV–V	0–0	IV–III
F. diversisporum	0–I–II	III–IV–IV	III–0–0
F. ensiforme	0–IV–IV	0–0–0	II–II–I
F. cumartii 1–I	0–0–0	V–V–V	0–II–0
F. cumartii 1–II	IV–0–IV	0–II–0	V–II–V
F. cumartii 2–I	III–III	IV–IV	0–0

[7] 0 signifies total absence of spores; I, very few; II, few; III, fair; IV, abundant; V, very abundant.

TABLE 4.—(*Continued*)

Organism	Microconidia	Macroconidia	Chlamydospores
F. eumartii 2–II	IV–II	III–III	II–IV
F. eumartii 3	IV–III	III–III	0–0
F. euoxysporum	III–II–III	III–0–I	V–V–V
F. falcatum	II–0–0–I	II–0–0–II	II–III–IV–III
F. filiferum I	I–0	I–I	V–V
F. filiferum II	0–0–0	V–V–V	IV–III–V
F. flocciferum	0–I–II	0–V–V	II–IV–V
F. fructigenum	0–0–0	0–0–0	0–0–0
F. fructigenum maius 1	0–0–II	III–III–III	III–0–III
F. fructigenum maius 2–I	0–0	V–V	0–0
F. fructigenum maius 2–II	0–0	V–V	0–0
F. fructigenum maius 2–III	0–0–0	II–0–II	0–0–0
F. fructigenum maius 2–IV	0–0–0	0–III–0	0–0–0
F. fructigenum maius 2–V	0–0	V–V	0–0
F. fructigenum maius 2–VII	0–I–0	0–II–0	0–0–0
F. fructigenum maius 2–VIII	0–I–0	0–I–0	0–I–0
F. fructigenum maius 3–I	0–0	0–0	0–0
F. fructigenum maius 3–II	IV–0–0	0–0–V	II–0–0
F. fructigenum maius 3–III	0–0	V–V	0–0
F. graminum 1	0–V–0	0–II–0	III–0–0
F. graminum 2–I	0–I	I–0	II–II
F. graminum 2–II	III–III	III–III	0–III
F. gibbosum	0–I–0	0–0–III	III–IV–V
F. herbarum 1	0–0–0	0–0–0	0–0–0
F. herbarum 2	II–0–II	II–0–II	0–0–0
F. herbarum gibberalloides I	IV–I–III	IV–IV–V	0–0–0
F. herbarum gibberalloides II	0–II–I	V–IV–V	0–0–0
F. herbarum pirinum I	0–0	III–II	0–0
F. herbarum pirinum II	0–0	0–0	0–0
F. hyperoxysporum 1	V–V–V	0–II–II	V–V–V
F. hyperoxysporum 2	V–V	III–III	0–0
F. incarnatum I	I–II	V–V	0–0
F. incarnatum II	0–II–0	0–III–I	0–0–0
F. incarnatum IV	II–II	IV–V	0–0
F. incarnatum V	II–II	IV–V	0–0
F. javanicum 1	III–III	III–II	V–V
F. javanicum 2	IV–III	I–0	V–V
F. lateritium I	0–0	IV–IV	0–0
F. lateritium II	0–0	0–0	0–0
F. lini	V–IV–V	III–0–0	IV–IV–V
F. lolii	0–0	III–III	0–0
F. loncheceras	V–IV	0–0	V–IV
F. loncheceras microsporum	III–II–V	0–I–0	II–III–III
F. longipes	I–IV	0–0	V–IV
F. lutulatum I	III–II	V–V	IV–III
F. lutulatum II	III–I	V–V	III–III
F. lycopersici 1	II–II	II–II	IV–II
F. lycopersici 2	IV–III	III–II	V–V
F. malli	V–IV–V	0–II–III	III–IV–V
F. macroceras	0–0	V–V	0–0
F. martii 1	V–IV–V	III–0–II	IV–IV–IV
F. martii 2	V–V	0–I	V–IV
F. martii 3–I	IV–III	0–0	IV–IV
F. martii 3–II	IV–III	0–0	IV–III
F. martii minus	IV–III	II–III	V–II
F. martii phaseoli 1–I	0–0–0	V–V–IV	0–II–III
F. martii phaseoli 1–II	V–0–V	0–0–0	V–II–V

TABLE 4.—(*Continued*)

Organism	Microconidia	Macroconidia	Chlamydospores
F. martii phaseoli 1–III	0–0–0	0–0–0	0–0–0
F. martii phaseoli 2–I	0–0	V–V	II–II
F. martii phaseoli 2–II	0–0	0–0	II–II
F. martii pisi	IV–IV	IV–II	IV–IV
F. martii viride	V–III–III	V–0–V	III–IV–V
F. moniliforme 1	V–V	0–I	0–0
F. moniliforme 2	V–V–V	0–III–II	0–0–0
F. moniliforme 3	IV–III	0–0	0–0
F. moniliforme 4	IV–III–III	0–II–0	0–0–0
F. moniliforme 5	III–III	0–I	0–0
F. moniliforme erumpens I	III–IV	V–III	0–0
F. moniliforme erumpens II	V–IV	IV–III	0–0
F. moniliforme minus	IV–IV	III–III	0–0
F. moniliforme subglutinans	V–II	IV–V	0–0
F. neoceras	II–IV	V–V	0–0
F. niveum 1	IV–IV	0–I	V–V
F. niveum 2	III–0–III	0–0–0	IV–V–IV
F. orthoceras	IV–III	0–I	V–IV
F. orthoceras triseptatum	V–IV–IV	0–II–II	IV–III–IV
F. ossicolum 1	0–IV–0	II–III–I	V–IV–V
F. ossicolum 2	III–0–I	V–V–V	V–0–III
F. oxysporum 1	II–III–III	IV–0–II	IV–V–V
F. oxysporum 2	V–IV–V	0–II–0	V–IV–V
F. oxysporum nicotianae	V–V	0–I	V–IV
F. paspalicola	0–0	II–IV	0–0
F. poae I	II–I	0–0	0–0
F. poae II	IV–IV	III–III	0–0
F. pirinum	II–0–0	III–0–II	0–0–0
F. polymorphum	0–0	III–III	II–V
F. pusillum	III–IV	IV–V	V–III
F. radicicola	V–IV–III	III–0–III	V–V–V
F. rhizochromatistes	V–IV	0–0	V–IV
F. rhizochromatistes-microsclerotium	III–IV	0–0	V–IV
F. sambucinum 1	I–II	V–V	0–0
F. sambucinum 2	IV–IV	0–0	IV–III
F. scirpi	0–0–0	0–0–0	0–III–III
F. sclerostromaton	IV–IV	III–II	IV–V
F. semitectum 1–I	IV–III–III	IV–V–V	0–II–0
F. semitectum 1–II	0–IV–V	0–III–0	0–II–III
F. semitectum 1–III	III–III–III	III–IV–IV	0–II–0
F. semitectum 1–IV	0–0–0	0–0–0	0–III–0
F. semitectum 1–V	0–0–0	0–0–0	0–II–0
F. semitectum 1–VI	0–0	0–0	0–0
F. semitectum 1–VII	0–0	0–0	0–III
F. semitectum 1–VIII	IV–V	III–II	IV–IV
F. semitectum 1–IX	0–0	0–0	0–0
F. semitectum 1–X	0–0	V–V	0–0
F. semitectum 1–XI	0–0	IV–IV	IV–IV
F. semitectum 1–XII	0–I	II–I	0–0
F. semitectum 1–XIII	0–0	II–III	0–0
F. semitectum 1–XIV	0–0	0–0	0–0
F. semitectum 1–XV	0–0	0–0	0–0
F. semitectum 1–XVI	0–0	0–0	0–0
F. semitectum 1–XVII	IV–III	IV–V	0–0
F. semitectum 1–XVIII	II–I	V–V	0–0
F. semitectum 2	II–0–II	III–III–III	IV–0–IV

TABLE 4.—(*Continued*)

Organism	Microconidia	Macroconidia	Chlamydospores
F. solani 1	IV–0–III	0–III–II	IV–V–IV
F. solani 2–I	V–V–V	0–II–0	IV–III–V
F. solani 2–II	II–IV	V–IV	III–IV
F. solani 3–I	II–III	V–V	IV–IV
F. solani 3–II	III–III	0–0	V–III
F. solani 3–III	IV–III	III–III	V–IV
F. solani 4–I	0–0	0–0	IV–III
F. solani 4–II	III–III	III–V	III–III
F. solani minus 1–I	IV–IV–IV	0–II–I	IV–IV–IV
F. solani minus 1–II	IV–IV	0–0	IV–IV
F. solani minus 2–I	III–III	IV–IV	III–III
F. solani minus 2–II	IV–IV–III	0–II–0	V–IV–II
F. solani suffuscum	II–II	0–0	V–V
F. spinaceae 1	V–IV	III–III	V–IV
F. spinaceae 2	V–IV	III–III	IV–IV
F. striatum 1–I	V–IV	0–0	V–IV
F. striatum 1–II	V–IV	0–0	II–IV
F. striatum 2	IV–III	IV–IV	IV–III
F. striatum 3–I	III–V–0	IV–II–0	V–V–0
F. striatum 3–II	IV–IV	IV–III	IV–III
F. sulphureum 1	0–0	III–II	0–0
F. sulphureum 2	0–0	V–V	0–0
F. sulphureum 3	0–0	V–V	0–0
F. theobrome	IV–III	0–0	IV–III
F. tracheiphilum	V–IV–V	II–III–II	0–III–II
F. trichothecioides 1	III–0–II	0–IV–0	0–0–0
F. trichothecioides 2–I	0–0	I–IV	0–0
F. trichothecioides 2–II	0–0	V–V	0–0
F. trichothecioides 2–III	0–0–0	II–0–III	0–0–0
F. trichothecioides 3–I	0–0–0	0–V–II	V–V–V
F. trichothecioides 3–II	I–II	II–III	0–0
F. trichothecioides 4–I	0–I–II	0–V–II	0–0–0
F. trichothecioides 4–II	I–0–0	IV–IV–III	IV–0–V
F. trichothecioides 5	III–0	0–0	IV–V
F. trichothecioides 6	V–IV	0–II	V–IV
F. trichothecioides 7–I	0–0	0–0	IV–IV
F. trichothecioides 7–II	IV–IV	III–II	0–0
F. tricinctum 1–II	II–IV–IV	II–V–III	0–0–0
F. tricinctum 1–III	III–IV–IV	IV–V–V	0–0–0
F. tricinctum 1–IV	III–IV–IV	IV–V–IV	0–0–0
F. tricinctum 1–V	III–IV–IV	IV–V–IV	0–0–0
F. tricinctum 1–VI	V–IV–V	III–IV–III	0–0–0
F. tricinctum 1–VII	II–IV–IV	II–V–III	0–0–0
F. tricinctum 1–VIII	0–IV–III	0–V–II	0–0–0
F. tricinctum 1–IX	III–IV–IV	IV–V–IV	0–0–0
F. tricinctum 2	II–0–II	IV–V–IV	0–0–0
F. uncinatum	IV–IV–IV	III–III–III	II–0–I
F. urticearum I	0–0	V–V	0–0
F. urticearum II	0–0	I–0	0–0
F. vasinfectum	I–0–II	IV–III–III	IV–IV–IV
F. viride 1	V–III–III	V–0–V	III–V–IV
F. viride 2	IV–V	II–I	V–V
F. viticola	III–0–0	IV–IV–V	0–0–0
F. zonatum 1	IV–II	0–0	IV–IV
F. zonatum 2	III–IV	V–III	II–V
F. zonatum 3	IV–III	IV–V	V–IV

possessing macroconidia, and 1–III is the only one which has no chlamydospores; in fact, it forms no spores at all. *F. moniliforme* 3 is devoid of macroconidia, and number 5 produces such bodies only sparsely and occasionally. *F. poae* II has macroconidia, *F. poae* I does not. *F. semitectum* 1–VI, 1–IX, 1–XIV, 1–XV, and 1–XVI are sterile; 1–XII, 1–XIII, 1–XVII, and 1–XVIII have no chlamydospores; only 1–VIII, 1–XII, 1–XVII, 1–XVIII, and number 2 form microconidia, and only 1–VIII, 1–X, 1–XI, 1–XII, 1–XIII, 1–XVII, 1–XVIII, and number 2 form macroconidia. *F. solani* 3–II produces no macroconidia, while 4–I produces neither micronor macroconidia. *F. striatum* 1–I and 1–II do not produce macroconidia, while number 2, 3–I and 3–II do. Only five of the twelve strains of *F. trichothecioides* yield chlamydospores, seven form microconidia and only two fail to give rise to macroconidia. *F. zonatum* is the only strain of the three members of this species which fails in the production of macroconidia. These are just a few examples. Similar results can be seen throughout the table. In addition, there is quite an inconsistency of results. At one time a culture may give rise to a large quantity of spores; at another, not a single spore can be found. No reaction seems to be free of such inconsistencies.

THE EFFECT OF TEMPERATURE ON GROWTH

Three temperatures, 5° C., 34° C., and 37.5° C., have been used in this experiment. Solid agar was found unsatisfactory because, in the first place, it adsorbs too much of the moisture and the inoculum cannot establish a rapid and efficient contact when the temperatures are so extreme. In the second place, the rapid drying of agar introduces unfavorable factors and leads the investigator to erroneous conclusions. A nutrient solution, prepared according to the formula given for malt-extract medium, but with the agar eliminated, was tried and found satisfactory. Since food concentration is not an inhibiting factor in the growth of Fusaria, evaporation from the solution under the high temperatures cannot be considered harmful.

Five c.c. of nutrient solution[8] was poured into each test-tube and sterilized. Immediately after the transfers were made the cultures were placed in the constant-temperature chambers and two weeks later the readings were made. The work was repeated at least once. The results are shown in table 5.

It can readily be seen that fluctuating reactions occur fairly abundantly even under such a standard environmental factor as temperature. Wher-

[8] Dry malt extract 10 g., dextrose 10 g., potassium nitrate 2 g., dihydrogen potassium phosphate 1 g., magnesium sulphate 1 g., distilled water 1,000 c.c. This solution was also used in experiments with tartaric acid, while in case of all the subsequent work it was somewhat modified by the elimination of malt extract.

TABLE 5.—*The effect of temperature on growth (two weeks at each temperature)*[9]

Organism	5° C.	34° C.	37.5° C.
F. acuminatum 1	0–I–0–0	IV–IV–IV	II–II
F. acuminatum 2–1	II–II–III	II–I	0–0–0
F. acuminatum 2–II	II–II–II	I–0	0–0–0
F. acuminatum 2–III	II–III–III	I–I	0–0–0
F. acuminatum 2–IV	II–III–III	I–0–I	0–0–0
F. acuminatum 2–V	I–II–I	0–0	0–0–0
F. acuminatum 2–VI	II–II–II	0–0	0–0–0
F. acuminatum 2–VII	III–III–III	II–I	0–0–0
F. acuminatum 2–VIII	II–III–III	I–0–II	0–0–0
F. alluviale	0–0	III–III	II–II
F. anthophilum	IV–V–IV	III–I	0–0–0
F. aquaeductuum pusilum	II–II–II	0–0	0–0
F. aquaeductuum volutum	II–III–III	0–0	0–0–0
F. arcuatum	III–IV–III	0–0	0–0–0
F. asclerotium	I–I–0	II–IV	0–I–I
F. aurantiacum	0–0–0	II–III	0–0
F. batatatis 1	0–0–0	V–V	II–II
F. batatatis 2	0–I–0	II–III	0–0
F. bulbigenum	I–I	IV–III	0–I–I
F. bullatum I	0–0–I–I	III–III	0–0
F. bullatum II	I–I–0	III–III	0–0–I–0
F. bullatum brevius	I–I	IV–V	0–0
F. camptoceras I	I–I–I	II–II–II	0–0–0
F. camptoceras II	I–I–I	II–II	0–0–0
F. caudatum	I–I–I	IV–IV	0–0
F. chlamydosporum I	I–0–0–0	V–V	III–I–II
F. chlamydosporum II	0–0–I–0	IV–IV	III–I–II
F. chlamydosporum III	0–0–0–0	V–V	III–I–II
F. chenopodinum	II–II–II	I–0–II	0–0–0
F. coeruleum 1–I	II–II–II–I	III–IV	I–0–I
F. coeruleum 1–II	I–0–I	III–V	0–0–0
F. coeruleum 2	I–I	IV–V	0–0
F. coeruleum 3	II–II	0–0	0–0–0
F. commutatum	III–IV–IV	II–II	0–0–0
F. conglutinans	0–0	I–I–II	0–0
F. cubense 1	0–0–0	III–III	0–0
F. cubense 2	0–0–0	III–V	0–0
F. culmorum 1–I	III–III	0–0	0–0–0
F. culmorum 1–II	II–III	I–I	0–0–0
F. culmorum 2	II–III–II	I–0–II–III	0–0–0
F. culmorum 3–I	I–II–IV	II–II	0–0–0
F. culmorum 3–II	I–II–II	II–II	0–0–0
F. culmorum 4–I	II–III–III	II–II	0–0–0
F. culmorum 4–II	II–III–IV	II–II	0–0–0
F. culmorum 5	III–II–I	II–II	0–0–0
F. culmorum 6–I	0–I–0	II–III	0–I–0–I–I
F. culmorum 6–II	II–II–II	II–II	0–0–0
F. decemcellulare	0–0–0	II–III	I–I–I
F. dimerum	0–0–0	IV–IV	III–III
F. diversisporum	I–0–I	III–V	0–0–0
F. ensiforme	0–0–0	III–III	0–0
F. eumartii 1–I	0–I–0	II–II	0–0–0
F. eumartii 1–II	0–0–0	I–III–IV	0–0–0
F. eumartii 2–I	II–II–III	0–0	0–0–0
F. eumartii 2–II	I–II–I	0–0	0–0–0

[9] 0 signifies no growth; I, very slight; II, slight; III, fair; IV, good; V, abundant.

TABLE 5.—(*Continued*)

Organism	5° C.	34° C.	37.5° C.
F. eumartii 3	I–II–I	II–I	0–0
F. euoxysporum	I–II–II	IV–IV	0–0
F. falcatum	0–0–I	II–II	0–0
F. filiferum I	I–I	0–I–I–II	0–0–0
F. filiferum II	II–II	0–I–II	0–0–0
F. flocciferum	II–II–IV	II–II	0–0–0
F. fructigenum	II–II–III	0–0	0–0–0
F. fructigenum maius 1	I–I–I	II–III	0–0
F. fructigenum maius 2–I	0–0–0	II–II	0–0
F. fructigenum maius 2–II	0–0–I–0	III–IV	0–0
F. fructigenum maius 2–III	0–0–I–0	II–III	0–0
F. fructigenum maius 2–IV	0–0	II–III	0–0
F. fructigenum maius 2–V	0–0–I	III–II	0–0–0
F. fructigenum maius 2–VII	0–0–I–0	I–0–II–II	0–0–0
F. fructigenum maius 2–VIII	0–0–I–0	II–III	0–0–0
F. fructigenum maius 3–I	II–III–0–II	0–0	0–0–0
F. fructigenum maius 3–II	II–III–II	0–0	0–0–0
F. fructigenum maius 3–III	II–III–III	0–0	0–0–0
F. graminum 1	II–II–III	II–I	0–0
F. graminum 2–I	0–0	IV–V	0–0
F. graminum 2–II	I–II–I–I	III–IV	0–0–0
F. gemmiperda	II–II–II	I–II	0–0
F. gibbosum	II–II–II	II–II	0–0
F. herbarum 1	II–III–II	0–0	0–0–0
F. herbarum 2	III–III–IV	0–0	0–0–0
F. herbarum gibberalloides I	II–II–III	0–0	0–0–0
F. herbarum gibberalloides II	III–III–IV	0–0	0–0–0
F. herbarum pirinum I	II–III–II	0–0	0–0–0
F. herbarum pirinum II	II–II–II	0–0	0–0
F. hyperoxysporum 1	0–I	IV–V	0–0
F. hyperoxysporum 2	0–0	II–III	0–I–0
F. incarnatum 1	0–I–0	V–V	0–0–0
F. incarnatum II	0–0	III–IV	0–0–0
F. incarnatum IV	I–I–0	IV–IV	0–0–0
F. incarnatum V	0–I–0	V–V	0–0–0
F. javanicum 1	0–0–0	IV–IV	II–III
F. javanicum 2	0–I–I	II–III	0–I–I
F. lateritium I	III–II–II	0–0	0–0–0
F. lateritium II	III–II–III	0–0	0–0–0
F. lini	I–I–I	IV–IV	0–0
F. lolii	II–III–II	III–II	0–0–0
F. loncheceras	0–I–I	II–III	0–0
F. loncheceras microsporum	0–I–I	III–II	0–0
F. longipes	0–0–0	V–II	I–I
F. lutulatum I	0–0–0	III–III	0–I–I–I
F. lutulatum II	0–0–0	III–III	0–I–I–I
F. lycopersici 1	0–0–0	IV–III	0–0
F. lycopersici 2	I–0–0	III–II	0–I
F. malli	I–I	V–IV	I–II–II
F. macroceras	II–II–II	II–II	0–0
F. martii 1	0–0–0	III–IV	II–II
F. martii 2	0–I–I	IV–IV	0–I–I
F. martii 3–I	0–0–0	III–IV	0–0–0
F. martii 3–II	0–0–0	III–IV	0–0–0
F. martii minus	0–0–0	IV–V	II–I
F. martii phascoli 1–I	0–0–0	II–II	0–0–0

TABLE 5.—(*Continued*)

Organism	5° C.	34° C.	37.5° C.
F. martii phaseoli 1–II	0–0–0	III–IV	0–0–0
F. martii phaseoli 1–III	0–0–0	II–II	0–0–0
F. martii phaseoli 2–I	III–II–0	II–II	0–0–0
F. martii phaseoli 2–II	0–0	II–II	0–0–0
F. martii pisi	0–0–0	II–II	0–I–I
F. martii viride	0–0–0	IV–V	III–III
F. moniliforme 1	I–0–0	IV–IV	II–II
F. moniliforme 2	I–I–0	III–III	0–0
F. moniliforme 3	II–II–II	0–0–0–0	0–0–0
F. moniliforme 4	II–II–0	IV–IV	I–I
F. moniliforme 5	II–II–I	III–IV	0–I–I
F. moniliforme erumpens I	I–I	V–IV	0–I–0–I
F. moniliforme erumpens II	I–I–I	IV–IV	0–I–II
F. moniliforme minus	I–0–0	IV–V	I–II
F. moniliforme subglutinans	I–I–I	IV–V	I–II
F. neoceras	I–II–II	III–II	0–0–0
F. niveum 1	0–II–0	III–IV	0–0
F. niveum 2	I–II–0	III–IV	0–0
F. orthoceras	I–I	II–III	0–0
F. orthoceras trisceptatum	I–I	II–III	0–0
F. ossicolum 1	0–I–0	III–III	0–0–0
F. ossicolum 2	III–0–III	III–III	0–0–0
F. oxysporum 1	0–I	III–IV	0–0
F. oxysporum 2	I–II	III–IV	0–I–I
F. oxysporum nicotianae	I–I	III–III	0–0
F. paspalicola	II–II–I	II–II	0–0
F. pirinum	III–III–II	II–II	0–0
F. poae I	III–III–II	II–II	0–0–0
F. poae II	III–IV–IV	III–III	0–0–0
F. polymorphum	III–III–III	II–II	0–0
F. pusillum	0–0–0	IV–V	II–II
F. radicicola	0–0–0	IV–IV	III–III
F. rhizochromatistes	I–I–I	I–II–III	0–I
F. rhizochromatistes-microsclerotium	I–I–I	II–II	0–0
F. sambucinum 1	III–III–IV	II–II	0–I
F. sambucinum 2	II–III–IV	III–II	0–0
F. scirpi	II–II–II	0–I–I	0–0
F. sclerostromatoides	I–I–I	III–IV	0–0
F. semitectum 1–I	0–I–0	II–II	0–0–0
F. semitectum 1–II	0–0–0	II–II	0–0–0
F. semitectum 1–III	0–I–I	III–III	0–0–0
F. semitectum 1–IV	0–I–I	II–III	0–0–0
F. semitectum 1–V	0–0–0	II–I	0–0–0
F. semitectum 1–VI	0–0–0	II–II	0–0–0
F. semitectum 1–VII	0–I–I–I	III–III	0–0–0
F. semitectum 1–VIII	0–I–0	II–III	0–0
F. semitectum 1–IX	0–I–I	II–II	0–0
F. semitectum 1–X	0–I–I	III–III	0–0
F. semitectum 1–XI	0–I–0	III–III	0–0
F. semitectum 1–XII	0–0–I	II–II	0–0
F. semitectum 1–XIII	0–I	II–IV	0–0
F. semitectum 1–XIV	0–I–0–I	II–I	0–0
F. semitectum 1–XV	0–0–I	II–II	0–0
F. semitectum 1–XVI	0–I–0	II–III	0–0
F. semitectum 1–XVII	0–I–I	IV–IV	0–0
F. semitectum 1–XVIII	I–I	III–III	0–0

TABLE 5.—(*Continued*)

Organism	5° C.	34° C.	37.5° C.
F. semitectum 2	0–I–I	IV–IV	0–0
F. solani 1	0–0–0	V–V	III–IV
F. solani 2–I	I–0–I	II–III	0–I–II–I
F. solani 2–II	I–II–II	V–V	II–III
F. solani 3–I	0–I–0	IV–V	III–III–IV
F. solani 3–II	0–0–0	IV–V	III–III–IV
F. solani 3–III	0–II–0	IV–V	III–III–IV
F. solani 4–I	0–II–0–0	IV–V	II–II–II
F. solani 4–II	I–II–0	IV–V–V	III–IV
F. solani minus 1–I	0–0–0	V–V	II–II–II
F. solani minus 1–II	0–0–0	III–IV	III–I
F. solani minus 2–I	0–0–0	IV–IV	III–III–IV
F. solani minus 2–II	0–0	III–IV	III–III–III
F. solani suffuscum	0–0–0	III–V	0–0–0
F. spinaceae 1	I–I	0–III–III	I–I–0
F. spinaceae 2	II–I–II	II–II	0–0
F. striatum 1–I	0–0–0	IV–V	II–II–II
F. striatum 1–II	0–0–0	IV–V	II–II–II
F. striatum 2	0–0–0	V–V	II–II
F. striatum 3–I	0–0	IV–V	III–III–II
F. striatum 3–II	0–I–0–0	V–IV	III–III–IV
F. sulphureum 1	III–III–0	0–0	0–0–0
F. sulphureum 2	III–IV–V	II–II	0–0
F. sulphureum 3	III–III–III	0–0	0–0
F. theobromae	0–0–0	III–V	0–0
F. trichothecioides 1	I–I–I	III–IV	0–I–II
F. trichothecioides 2–I	II–II–III	0–0	0–0–0
F. trichothecioides 2–II	III–IV–III	0–0	0–0–0
F. trichothecioides 2–III	III–III–III	0–0	0–0–0
F. trichothecioides 3–I	II–III–II	II–II	0–0–0
F. trichothecioides 3–II	II–III–III	0–0	0–0–0
F. trichothecioides 4–I	I–I	IV–III	0–I–I–I
F. trichothecioides 4–II	II–II	I–II	0–0–0
F. trichothecioides 5	I–0–I	II–III	0–0
F. trichothecioides 6	I–I–II	II–III	II–II–II
F. trichothecioides 7–I	0–0–0	V–V	0–0–0
F. trichothecioides 7–II	II–II–II	0–0	0–0–0
F. tricinctum 1–II	II–II–III	0–0	0–0–0
F. tricinctum 1–III	II–II–III	0–0	0–0–0
F. tricinctum 1–IV	II–II–III	0–0	0–0–0
F. tricinctum 1–V	II–II–III	0–0–I	0–0–0
F. tricinctum 1–VI	II–II–III	0–0	0–0–0
F. tricinctum 1–VII	II–II–I	0–0	0–0–0
F. tricinctum 1–VIII	II–II–III	0–0	0–0–0
F. tricinctum I–IX	II–II–II	0–0	0–0–0
F. tricinctum 2	II–III–I	0–I–I	0–0
F. uncinatum	0–I–I–II	III–III	0–0–0
F. urticearum I	IV–IV–IV	0–0	0–0–0
F. urticearum II	II–III–III	0–0–0	0–0
F. vasinfectum	I–0–0	III–III	III–III
F. viride 1	0–0–0	III–IV	0–I–I
F. viride 2	0–0–0	III–IV	0–0
F. viticola	IV–IV–V	0–0	0–0
F. zonatum 1	I–II–II	III–IV	0–0
F. zonatum 2	I–I–I	II–III	0–0
F. zonatum 3	I–I–I	II–III	0–0

ever the reaction is indicated as 0, it does not, necessarily, mean that the inoculum was killed by the adverse temperature. Sometimes it was dead after exposure to 37.5° C. Sometimes it was not. All cultures failing to show any growth at this high temperature within two weeks were transferred to a chamber maintained at a constant temperature of 25° C. and were kept there for an additional two weeks. When examined at the end of this period, it was observed that some showed a vigorous growth, while others failed to manifest any sign of life. At first it was believed that this would give a very good differentiation; but, when the experiment was repeated and the cultures were transferred from the high to the low temperature, it was seen that many of the organisms, which in a previous attempt showed no sign of life, started to make a vigorous growth. For example, *F. aquaeductuum pusilum, F. chenopodinum, F. coeruleum* 3, *F. culmorum* 1–I and II, *F. eumartii* 1–II, *F. fructigenum,* all the variants of *F. fructigenum maius* 2, *F. herbarum* 2, *F. herbarum gibberalloides* I and II, *F. lini, F. martii phaseoli* 1–I, II, and III, *F. neoceras, F. ossicolum* 2, *F. paspalicola, F. sambucinum, F. semitectum* 1–II, IV, V, and VII, *F. solani suffuscum, F. sulphureum* 1, *F. trichothecioides* 1 and 3–III, all the variants of *F. tricinctum* 1 except IV, and many others were found dead after two weeks at 37.5°. When, however, the work was repeated once or twice, it was found that, although there was no growth while the cultures were kept at 37.5° C., they started growing vigorously shortly after transfer to the lower temperature. It might be assumed that slight temperature variations would suffice to break the balance, but duplicate cultures kept under identical conditions showed totally different results. One would be dead, while the other had retained its vitality notwithstanding the fact that the inoculum consisted of two pieces of mycelium of the same age and size and both pieces were removed from the same region in the colony.

The reactions of different strains of the same species toward temperature are by no means uniform. Numerous examples can be given, but the following are sufficiently representative:

F. acuminatum 1 grows at 37.5° C., while all the strains of *F. acuminatum* 2 do not.

F. batatatis 1 tolerates the high temperature; no. 2 fails to do so.

F. coeruleum 3 is the only strain of this species unable to grow at 34° C.

F. culmorum 1–I is the only strain of this species incapable of growth at 34° C., just as *F. culmorum* 6–I is the only one showing any aversion to very low temperatures.

F. eumartii 2–I and 2–II do not grow at 34° C., while the other strains of this species are not inhibited by this temperature.

F. fructigenum maius 3–I, 3–II, and 3–III do not grow at 34° C., while no. 1 and all the mutants of no. 2 grow at this temperature.

F. graminum 2–I is inhibited by the low temperature, while 2–II and no. 1 are not.

F. moniliforme 3 is the only strain of this species unable to grow at 34° C.

F. sulphureum 2 tolerates 34° C., while nos. 1 and 3 do not.

F. trichothecioides 1, 4–I, and 7–I are the only ones among the twelve strains of this fungus capable of making some growth at 37.5° C., and nos. 2–I, 2–II, 2–III, 3–II, and 7–II are the only ones unable to grow at 34° C.

Most of the organisms which can grow at 5° C. can not tolerate 37.5° C.; and most of those that grow at the high temperature are inhibited by the low. However, there are some exceptions and a generalization is not at all permissible.

Some remarkably uniform reactions toward temperature are to be noted among the strains of various species. Such instances indicate the possibility of developing more comprehensive and more widely inclusive tests whereby the sphere of individual variations can be more readily determined and the proper segregation of species accomplished on a more dependable basis.

Growth in presence of various concentrations of tartaric acid

Nine different concentrations of tartaric acid were used in this experiment. Weighed amounts of the crystals of the acid were added to the nutrient solution, which was then tubed and sterilized. Readings were made after one week's incubation at 25° C. All experiments which gave significant results were repeated at least once; some were repeated several times. When, however, a fungus made a good growth in the presence of 1 per cent tartaric acid, for example, it was not deemed necessary to repeat the work with 0.75 per cent concentration; or, if it failed to grow when the concentration of tartaric acid was 1 per cent, it was believed to be inadvisable to try 2 per cent acid more than once.

In view of the fact that tartaric acid does not kill the inoculum even when present in high concentrations, seven days was judged to be sufficient for the appearance of growth. Ordinarily, when no inhibiting substances are present in the nutrient solution, the inoculum shows growth within 24 hours. While it is probable that in some case an extension of the incubation period would have permitted growth, it is not the purpose of this paper to demonstrate whether or not these fungi can grow in the presence of a given concentration of tartaric acid, but rather to obtain a differential growth, subject to the limits of the experiment. The following table gives the results.

The same lack of uniformity characterizing the behavior of the different strains of a given species is apparent throughout table 6. Why should *F.*

TABLE 6.—*Growth in presence of various concentrations of tartaric acid (7 days at 25° C.)*

Organism	0.18%	0.37%	0.75%	1%	1.5%	2%	3%	4%	5%
F. acuminatum 1	III–IV	I–II	I–I	0–I	0–0	0–0	0–0	0–0	0–0
F. acuminatum 2–I	III–I	II–I–I	0–0–0	0	0	0	0	0	0
F. acuminatum 2–II	IV–II	I–I	0–0	0	0	0	0	0	0
F. acuminatum 2–III	III–II	III–II–0	I–0–0	0–0	0	0	0	0	0
F. acuminatum 2–IV	III–II	II–I	0–0–0	0	0	0	0	0	0
F. acuminatum 2–V	III–0	III–I–0	I–0–0	0–0	0	0	0	0	0
F. acuminatum 2–VI	IV–III	III–I–I	I–0–0	0–0	0	0	0	0	0
F. acuminatum 2–VII	V–III	IV–I	III–0–0	0–0	0	0	0	0	0
F. acuminatum 2–VIII	IV–III	III–0–II	0–0	0	0	0	0	0	0
F. alluviale	IV–III	I–I–II	0–0	0–0	0–0	0–0	0–0	0–0	0–0
F. anthophilum	III	III–II	0–I–I	0–0	0	0	0	0	0
F. aquaeductuum pusilum	II–0	II–0	II–0	II–0	II–0	II–0	0–0	0–0	0–0
F. aquaeductuum volutum	0–I	0–0	0	0	0	0	0	0	0
F. arcuatum	0–II–I	0–0–0	0	0	0	0	0	0	0
F. asclerotium	V	V	V	V	IV–III	II–0	II–0	I–0–0	0–0
F. aurantiacum	V	V	V	IV	III–III	II–III	II–I	0–0	0
F. batatatis 1	V–II	V–IV	IV–0	IV–0	III–0	II–0	I–0	0–0	0
F. batatatis 2	V	V	IV–V	IV–V	III–III	II–I	I–0	0–0	0
F. bulbigenum	V	V	V	V	IV–III	II–III	II–I–I	0–0	0
F. bullatum I	V	V	IV	III–I–0	III–0–0	II–0–0	0–0	0	0
F. bullatum II	IV	III–III	0–II–II	0–I–0	0–0	0	0	0	0
F. bullatum brevius	V	V	III	III–II	II–I–0	0–I–0	0	0	0
F. camptoceras I	V–V	IV–V	III–I–0	I–0–I	0–0	0	0	0	0
F. camptoceras II	V	V	IV–I	II–0–I	0–0	0	0	0	0
F. caudatum	IV	IV–II–0	III–0–0	II–0–0	0–0–0	0	0	0	0
F. chlamydosporum I	III	III	II–II	II–0–I	0–0–0	0	0	0	0
F. chlamydosporum II	III	III	II–II	II–II	I–0	I–I–0	0–0	0	0
F. chlamydosporum III	III	III–II	II–I	I–I	I–0	I–0	0–0	0	0
F. chenopodinum	III–IV	II–II–0	0–0–0	0	0	0	0	0	0
F. coeruleum 1–I	III–IV	II–II–I	0–0–0	0	0	0	0	0	0
F. coeruleum 1–II	I–II–II	0–0–0	0	0	0	0	0	0	0
F. coeruleum 2	II–III	I–II	0	0	0	0	0	0	0
F. coeruleum 3	0–0–0	0–0	0	0	0	0	0	0	0
F. commutatum	III–I	II–II–I	I–0–0	0–0	0	0	0	0	0
F. conglutinans	V	IV	IV	IV–III	II–0	I–0	0–0	0	0

TABLE 6.—*Continued*

Organism	0.18%	0.37%	0.75%	1%	1.5%	2%	3%	4%	5%
F. cubense 1	IV	IV	IV	III	II–0	I–II–0	0–0–0	0	0
F. cubense 2	V	V	V	V–IV	III–I	II–0	II–0–0	I–0	0–0
F. culmorum 1–I	III	III–III	II–II	I–I	0–I	0	0	0	0
F. culmorum 1–II	III	III–II	II–I	II–I	I–0	0	0	0	0
F. culmorum 2	IV	IV–III	III–I	II	I–0	0–0	0	0	0
F. culmorum 3–I	V–III	II–0–II	0–0	0	0	0	0	0	0
F. culmorum 3–II	II–I–I	0–0–0	0	0	0	0	0	0	0
F. culmorum 4–I	IV–II	III–0–II	0–0–0	0	0	0	0	0	0
F. culmorum 4–II	III–III	III–0–0	0–0–0	0	0	0	0	0	0
F. culmorum 5	III–I	I–0	0–0	0	0	0	0	0	0
F. culmorum 6–I	V	V	V	V–V	IV–III	II–0–0	II–0–0	0	0
F. culmorum 6–II	III–II	II–II	I–I	I–I	0	0	0	0	0
F. decemcellulare	I–0–0	0–0–0	0	0	0	0	0	0	0
F. dimerum	III	III–III	0–0	0	0	0	0	0	0
F. diversisporum	IV	IV	III–0	II–0–0–I	0–0–0	0–0	0–0	0	0
F. ensiforme	II–II–I	0–0–0	0–0	0	0	0	0	0	0
F. eumartii 1–I	0–0	0–0	0	0	0	0	0	0	0
F. eumartii 1–II	0–IV–IV	0–II–II	0–0	0	0	0	0	0	0
F. eumartii 2–I	I–II–II	0–I–I	0	0	0	0	0	0	0
F. eumartii 2–II	II–II–II	0–0–0	0	0	0	0	0	0	0
F. eumartii 3	III–III	0–0	0	0	0	0	0	0	0
F. euoxysporum	V	V	IV–III	III–II	II–0–0	0–0	0	0	0
F. falcatum	IV	III–II	II–I–I	0–0	0	0	0	0	0
F. filiferum I	III–V	II–IV	I–0–I	0–0	0	0	0	0	0
F. filiferum II	IV–V	IV–V	III–0–I	II–0–I	0–0	0	0	0	0
F. flocciferum	0–V–V	0–0–I	0	0	0	0	0	0	0
F. fructigenum	I–I–I	0–0–0	0	0	0	0	0	0	0
F. fructigenum maius 1	III–IV–IV	0–I–I	0–0	0	0	0	0	0	0
F. fructigenum maius 2–I	III–IV	II–I–0–0	0–0	0	0	0	0	0	0
F. fructigenum maius 2–II	IV–IV	II–I–II–I	0–0	0	0	0	0	0	0
F. fructigenum maius 2–III	III–IV–IV	0–0–I	0–0	0	0	0	0	0	0
F. fructigenum maius 2–IV	IV–V	II–I–I	0–0	0	0	0	0	0	0
F. fructigenum maius 2–V	III–III	III–II–I	0–0	0	0	0	0	0	0
F. fructigenum maius 2–VII	IV	II–I	0–0	0	0	0	0	0	0
F. fructigenum maius 2–VIII	III–IV–IV	II–I–I	0–0	0	0	0	0	0	0

TABLE 6.—*Continued*

Organism	0.18%	0.37%	0.75%	1%	1.5%	2%	3%	4%	5%
F. fructigenum maius 3–I	II–II–II	I–0–0–0	0–0	0	0	0	0	0	0
F. fructigenum maius 3–II	I–IV	0–0	0	0	0	0	0	0	0
F. fructigenum maius 3–III	III–IV–III	0–0–0	0–0	0	0	0	0	0	0
F. gibbosum	V	IV	III–0–II	II–0–I	I–0–0	0–0	0	0	0
F. graminum 1	III–V	0–0	0	0	0	0	0	0	0
F. graminum 2–I	III–IV	II–II	0–0	0	0	0	0	0	0
F. graminum 2–II	IV–IV	IV–III	II–0–0	I–0–0	0	0	0	0	0
F. herbarum 1	0–I–II	0–0–I	0–0	0	0	0	0	0	0
F. herbarum 2	III	II–III–II	0–I–0	0	0	0	0	0	0
F. herbarum gibberalloides I	IV–V	III–IV	III–I	0–0	0	0	0	0	0
F. herbarum gibberalloides II	IV–V	III–V	III–I–III	0–0	0	0	0	0	0
F. herbarum pirinum I	II–II	II–0–0	0–0–0	0	0	0	0	0	0
F. herbarum pirinum II	II–II	II–0–0	0–0–0	0	0	0	0	0	0
F. hyperoxysporum 1	V	V	V	V	IV–III	III–II	I–0	0	0
F. hyperoxysporum 2	V	V	V	V–V	II–III	II–I	I–0	0	0
F. incarnatum I	V	IV	III–II	II–I–I	0–0	0	0	0	0
F. incarnatum II	V–V	IV–III	III–0	II–0–0	0–0	0	0	0	0
F. incarnatum IV	V	V	III–I	I–I–0	0–I–0	0	0	0	0
F. incarnatum V	V–V	IV–III	III–0–I	II–0–0	I–0–0	0–0	0	0	0
F. javanicum 1	IV	IV	III–II–II	I–0–I–0	0	0	0	0	0
F. javanicum 2	V	V	V	IV–III–I	III–II–0	II–0–0	II–0–0	I–0–0	0–0
F. lateritium I	0–0–0	0–0	0	0	0	0	0	0	0
F. lateritium II	0–II	0–0	0	0	0	0	0	0	0
F. lini	III	III–III–II	0–I–0	0	0	0	0	0	0
F. lolii	III–III	II–II	II–I–I	I–0–I	0–0	0	0	0	0
F. loncheceras	V	V	IV	IV–III	III–III	II–0–III–0	I–0–I	0–0	0
F. loncheceras microsporum	V	V	V	V–V–III	IV–III–II	II–0–II	II–0–0	0–0	0
F. longipes	II–II	II–I–0	0–0	0	0	0	0	0	0
F. lutulatum I	IV	IV	IV	III–IV	III–II	I–I	I–0	0–0	0
F. lutulatum II	V	V	V	IV–IV	III–III	I–I	I–I	0–0	0
F. lycopersici 1	V	V	IV	V	III–II–IV	I–I–0	0–I	0	0
F. lycopersici 2	V	V	V	V–V	IV–III	III–0–II	I–0–0	0–0	0
F. malli	V	V	IV	III–IV	II–III	II–III	II–II	0–I	0
F. macroceras	IV	III	III	III–I	II–0	II–I–0	0	0	0
F. martii 1	III–IV	II–II–II	0–0	0	0	0	0	0	0

TABLE 6.—*Continued*

Organism	0.18%	0.37%	0.75%	1%	1.5%	2%	3%	4%	5%
F. martii 2	V	V	V	V	IV	III	II–0	0–0	0
F. martii 3–I	IV	II–II–II	0–II–I–0	I–0–0	0	0	0	0	0
F. martii 3–II	IV	II	0–II	I	0	0	0	0	0
F. martii minus	III–IV	II–II–II	0–0	0	0	0	0	0	0
F. martii phaseoli 1–I	0–I–0	0–0	0	0	0	0	0	0	0
F. martii phaseoli 1–II	0–V–0	0–II	0–I	0	0	0	0	0	0
F. martii phaseoli 1–III	0–0–0	0–0	0	0	0	0	0	0	0
F. martii phaseoli 2–I	0–0–0	0–0	0	0	0	0	0	0	0
F. martii phaseoli 2–II	0–0–0	0	0	0	0	0	0	0	0
F. martii pisi	III–V	II–V	I–III–III	0–I–III	II	II	I–0	0	0
F. martii viride	III	II–III–III	0–I–II	0–0	0	0	0	0	0
F. moniliforme 1	V	V	V	V	IV	IV	III–I	II–0–I	II–0–0
F. moniliforme 2	IV	IV	IV	IV	IV	III–I	II–0	I–0–0	I–0–0
F. moniliforme 3	0–III	0–0	0	0	0	0	0	0	0
F. moniliforme 4	V	V	V	V–IV	IV–III	III–0–II	I–0–0	0–0	0
F. moniliforme 5	V	V	V	V	IV–IV	IV–IV–0	III–0–II	I–0–0–II	I–0–0
F. moniliforme erumpens I	V	V	V	IV	IV–III	III–II–0	II–0–0	0–0	0
F. moniliforme erumpens II	V	V	V	V	IV	IV–I	II–I–0	I–0–0	0–0
F. moniliforme minus	V	IV	IV	IV	IV	IV–0–III	III–I–0	II–I–0	0–0–0
F. moniliforme subglutinans	V	V	IV	IV	III–III	II–II	I–I–I	0–0	0
F. neoceras	V	IV	IV	IV–IV	III–II	II–0	0–0	0	0
F. niveum 1	V	V	V	IV	IV–0	III–I–0	II–0–0	0–0	0
F. niveum 2	V	V	IV	III	II–0	II–I–0	0–0	0–0–0	0
F. orthoceras	IV	IV	IV	III–III	II–II	II–I–I	I–0–I	0–0	0
F. orthoceras triseptatum	V	V	V	IV	IV–IV	II–0–III	II–I–I–0	0–I–0	0
F. ossicolum 1	IV	IV	IV	IV–0	III–0	II–I–0	0–0	0	0
F. ossicolum 2	V–V	III–0–II	0–0–0	0	0	0	0	0	0
F. oxysporum 1	V	V	V	IV–IV	II–I	II–0	I–0–0	0–0	0
F. oxysporum 2	V	V	V	IV–IV	III–0	II–I	I–0	0–0	0
F. oxysporum nicotianae	V	V	V	IV–0	III–III	II–II	I–I	0–0	0
F. paspalicola	III–III	II–II	I–I	0–0	0	0	0	0	0
F. pirinum	V–V	III–IV	II–0–I	0–0	0	0	0	0	0
F. poae I	III–II–III	0–0–I	0	0	0	0	0	0	0
F. poae II	II–IV	0–III–III	0–0	0	0	0	0	0	0
F. polymorphum	III–IV	II–I–II	0–0	0	0	0	0	0	0

TABLE 6.— (*Continued*)

Organism	0.18%	0.37%	0.75%	1%	1.5%	2%	3%	4%	5%
F. pusillum	IV–IV	III–IV–IV	0–I–0	0	0	0	0	0	0
F. radicicola	IV–V–II	II–II–II	0–0	0–0	0	0	0	0	0
F. rhizochromatistes	V	V	V	V–V	IV–IV	III–0–III	III–0–I	0–0–0	0
F. rhizochromatistes-microsclerotium	V–V	IV–V	IV–III	III–III	II–0–II	II–0–I	0–0–0	0	0
F. sambucinum 1	III–IV	II–II–III	0–I–0	0	0	0	0	0	0
F. sambucinum 2	IV	IV–III	III–II	II–I–II	I–0	0–0	0	0	0
F. scirpi	III–III	II–II–III	0–0	0	0	0	0	0	0
F. sclerostromaton	V	V	V	IV–IV	IV–I	II–I–0	II–0–0	0–0–0	0
F. semitectum 1–I	IV–IV–IV	IV–IV–IV	III–II–I	II–I–I	I–I–0	0–0	0	0	0
F. semitectum 1–II	V–V–V	V–IV–II	IV–I–II	II–0–I	I–0	0	0	0	0
F. semitectum 1–III	IV–V–V	IV–III–IV	III–II–II	II–II	I–I	0–0	0	0	0
F. semitectum 1–IV	IV–IV–V	III–IV–III	III–I–0	II–0–0	0–0	0	0	0	0
F. semitectum 1–V	IV–IV–III	III–0–II	III–0–I	II–0–I	0–0–0	0	0	0	0
F. semitectum 1–VI	V–III	IV–II–II	III–0–0	II–0–0	II–0–0	0	0	0	0
F. semitectum 1–VII	III–IV–IV	II–0–I	I–0–I	0–0–I	0–0	0	0	0	0
F. semitectum 1–VIII	V–V	V–V	V–V	V–II–V	IV–II–0–III	II–II–0–I	II–0–I	0	0
F. semitectum 1–IX	V–V–III	0–II–III	I–I	0–0	0–0	0–0	0–0	0	0
F. semitectum 1–X	V–V–V	V–IV	II–II–III	0–0–I	0–0	0–0	0	0	0
F. semitectum 1–XI	V–V–V	V–III	I–II–II	0–0–0	0	0	0	0	0
F. semitectum 1–XII	V–IV–III	IV–III	I–I–II	0–I	0	0	0	0	0
F. semitectum 1–XIII	V–IV	III–III	0–II	I–I–0	0–I–0	0	0	0	0
F. semitectum 1–XIV	III–III–II	0–0–I	0–0	0–0	0	0	0	0	0
F. semitectum 1–XV	III–0–III	0–0–I	0–0–I	0	0	0	0	0	0
F. semitectum 1–XVI	IV–III–III	0–II	I–I	0–0	0–I	0	0	0	0
F. semitectum 1–XVII	V–V–IV	IV–IV	III–III–III	II–0	I–0	0–0	0–0	0–0	0
F. semitectum 1–XVIII	IV–V	III–III	II–III	0–0	0–0	0	0	0	0
F. semitectum 2	IV	IV	III–III	II–I–II	I–I–0	0–0	0	0	0
F. solani 1	III–IV	II–II–II	0–0	0	0	0	0	0	0
F. solani 2–I	V	V	IV	III–IV	II–III	II–II	0	0	0
F. solani 2–II	V–V	V–I–III	IV–0–II	III–0–I	II–0–0	II–0–0	0–0	0	0
F. solani 3–I	V	III	III–I	II–I–0	II–0–0	0–0	0	0	0
F. solani 3–II	V–V	IV–III–II	0–0–0	0	0	0	0	0	0
F. solani 3–III	II–V–V	I–IV–0	0–II–0	0	0	0	0	0	0
F. solani 4–I	I–III–I	I–0–0	0–0	0	0	0	0	0	0

TABLE 6.—(*Continued*)

Organism	0.18%	0.37%	0.75%	1%	1.5%	2%	3%	4%	5%
F. solani 4–II	IV–IV	III–II–I	II–I–0	II–0–0	0	0	0	0	0
F. solani minus 1–I	II–V	II–IV–II	0–0–0	0	0	0	0	0	0
F. solani minus 1–II	IV–IV	III–II–II	0–0–0	0	0	0	0	0	0
F. solani minus 2–I	IV–III	II–II–I	I–0–0	0–0	0	0	0	0	0
F. solani minus 2–II	II–II–II	0–0–I	0	0	0	0	0	0	0
F. solani suffuscum	III–IV	II–0–II	0–0	0	0	0	0	0	0
F. spinaceae 1	V	V	IV	IV–III	III–III	II–II	0	0	0
F. spinaceae 2	V	V	V	V	IV–II	III–I	II–I	I–0	0–0
F. striatum 1–I	III–IV–III	0–II–II	0	0	0	0	0	0	0
F. striatum 1–II	0–0–0	0–0–0	0	0	0	0	0	0	0
F. striatum 2	III–III	II–II	I–I–I	0–0	0	0	0	0	0
F. striatum 3–I	IV–III–IV	II–II–II	0–0–0	0	0	0	0	0	0
F. striatum 3–II	I–0–V	0–0–III	0–0	0–0	0	0	0	0	0
F. sulphureum 1	III–I–IV	I–0–0	0–0	0	0	0	0	0	0
F. sulphureum 2	IV–IV	II–I–II	0–0	0	0	0	0	0	0
F. sulphureum 3	IV–V	III–IV–IV	0–I–I	I–0	0–0	0	0	0	0
F. theobrome	IV–IV	III–II	II–II	0–0	0	0	0	0	0
F. tracheiphilum	V	V	V	V–V	II–0	II–0	II–0–0	I–0	0–0
F. trichothecioides 1	II–IV–II	0–I–0	0	0	0	0	0	0	0
F. trichothecioides 2–I	V–II	II–0	0–0	0	0	0	0	0	0
F. trichothecioides 2–II	V	III–III	I–0	0–0	0	0	0	0	0
F. trichothecioides 2–III	II–I–0	0–0–0	0–0	0	0	0	0	0	0
F. trichothecioides 3–I	V	III–II	III–0–II	II–0–0	0–0	0	0	0	0
F. trichothecioides 3–II	I–II	I–0	0–0	0	0	0	0	0	0
F. trichothecioides 4–I	0–I	0	0	0	0	0	0	0	0
F. trichothecioides 4–II	III–IV–IV	0–IV–III	0–0–II	0–0	0–0	0	0	0	0
F. trichothecioides 5	V	V	V	III–II	II–0	II–0	I–0	0–0	0
F. trichothecioides 6	V	V	V–V	IV–V	II–II	0–I	0	0	0
F. trichothecioides 7–I	II–IV–II	0–0–0	0	0	0	0	0	0	0
F. trichothecioides 7–II	I–V–III	0–0–0	0	0	0	0	0	0	0
F. tricinctum 1–II	III–IV–IV	I–II–III	0–0–II	0	0	0	0	0	0
F. tricinctum 1–III	II–IV	II–III–III	0–0–I	0	0	0	0	0	0
F. tricinctum 1–IV	IV	III	II–I	0–0	0	0	0	0	0
F. tricinctum 1–V	IV–V	III–IV	II–0–I	0–0	0	0	0	0	0
F. tricinctum 1–VI	III–V	II–V	I–0–V	0–0–0	0	0	0	0	0

TABLE 6.—(*Continued*)

Organism	0.18%	0.37%	0.75%	1%	1.5%	2%	3%	4%	5%
F. tricinctum 1–VII	II–0–III	0–0–I–II	0–0	0	0	0	0	0	0
F. tricinctum 1–VIII	III–III	II–II	0–0	0	0	0	0	0	0
F. tricinctum 1–IX	III–IV	I–II–III	0–0–I	0	0	0	0	0	0
F. tricinctum 2	III–III–III	I–I–I	0–0–0	0	0	0	0	0	0
F. uncinatum	IV	IV	IV–III	III–III	II–I–II	0–I	0–0	0	0
F. urticearum I	II–V–III	0–0–I	I–0	0–0	0	0	0	0	0
F. urticearum II	0–I–0	0–0–0	0	0	0	0	0	0	0
F. vasinfectum	V	V	V	IV–III	II–I	II–I–I	I–0–0	I–0–0	0–0
F. viride 1	IV–IV	II–0–II	0	0	0	0	0	0	0
F. viride 2	V	V	V	V	IV–IV	III–0	II–0	I–0	0–0
F. viticola	IV–IV	III–III–III	I–I–II	I–0	0	0	0	0	0
F. zonatum 1	III	III	II	II–II–II	0–I–0	0	0	0	0
F. zonatum 2	V	V	V	V–II	III–0	II–0	I–I	0–0	0
F. zonatum 3	V	V	V	V	IV–III	II–0	I–I–0	0–0	0

coeruleum 3 fail to grow in presence of 0.18 per cent tartaric acid, while *F. coeruleum* 1–I, 1–II and 2 grow fairly well? Why should *F. culmorum* 6–I make an excellent growth in presence of 1.5 per cent of the acid, while *F. culmorum* 3–II fails to make any growth, even when the concentration of tartaric acid is no more than 0.37 per cent? Of the five strains of *F. eumartii,* no. 1–I is the only one unable to grow in the presence of 0.18 per cent tartaric acid. *F. martii* 1–I is totally inhibited by 0.75 per cent of the acid, while *F. martii* 2 is not inhibited, even by 2 per cent concentration of the same acid. Of all the strains of *F. moniliforme,* no. 3 is the only one which is inhibited by a concentration of only 0.37 per cent of tartaric acid, while the others withstand as much as 2 per cent or more. *F. semitectum* 1–VIII tolerates more acid than any of the other strains. *F. solani* 2–I withstands 2 per cent of the acid, while 3–II and 4–I show no sign of growth when the amount of acid present is more than 0.37 per cent. *F. striatum* 1–I grows in the presence of 0.18 and even 0.37 per cent of the acid, while no. 1–II does not. *F. trichothecioides* 4–I can hardly tolerate 0.18 per cent of the acid, while no. 6 grows even when the concentration is increased to 1.5 per cent. *F. viride* 2 can tolerate as much as 1.5 and 2 per cent of tartaric acid, while the upper limit of acid tolerance for no. 1 is not more than 0.37 per cent.

On the other hand, there are numerous instances where the different strains of the same species exhibit a remarkably uniform set of reactions. All strains of *F. acuminatum* tolerate only small amounts of acid; the same applies to *F. fructigenum* and its varieties. With only one exception all the strains of *F. moniliforme* can grow in the presence of high concentrations of tartaric acid. Both strains of *F. batatatis,* of *F. camptoceras,* the three strains of *F. chlamydosporum, F. cubense* 1 and 2, *F. herbarum gibberalloides* I and II, *F. hyperoxysporum* 1 and 2, *F. lutulatum* I and II, *F. lycopersici* 1 and 2, and many others agree very closely in their reactions toward tartaric acid.

Because of the inconstancy of results noted in many cases, this type of fluctuating variation was tested further in an extensive series of experiments. It was deemed advisable also to make certain that such conflicting results as are listed in the foregoing table were not caused by any error in technique but were attributable to the nature of the living protoplasm. All organisms showing strikingly conflicting reactions were studied for two generations to determine whether a more comprehensive range of variations could be established. If, for example, a given inoculum failed to make any growth in the presence of 2 per cent tartaric acid, it was subsequently transferred to a tube of nutrient solution void of any inhibiting substance. After a good growth was obtained, it was transferred to agar plates and inoculum discs were cut from the resulting colony and transferred to a series of tubes

of nutrient solution containing 1.5, 2, and 3 per cent of tartaric acid. The results are given below. Arrows indicate the course of procedure from beginning to end. For instance, an inoculum disc cut from a colony of *F. asclerotium* and transferred to 2 c.c. of nutrient solution containing 2 per cent tartaric acid fails to make any growth. When, after 7 days, it is transferred to a nutrient solution containing no tartaric acid, it begins to grow vigorously, showing that it was not killed by the acid but merely inhibited. A transfer is made from this growth to a plate of agar and from the resulting colony inoculum discs are cut and transferred to 0.75, 1, 1.5, and 2 per cent tartaric acid solutions; all of them grow, as indicated by the numerals V, IV, III and II. The following pages illustrate such reactions in condensed form.

The foregoing facts need no further explanation. The organisms used are numerous enough to exclude the possibility of accidental mixtures or contaminations. Some of the experiments have been repeated a number of times from every angle, to eliminate, as much as possible, any environmental factor that may have been introduced into the work. It seems, therefore, that the cause for the extreme fluctuations exhibited by these organisms is to be found not in the external environmental factors but within the mechanism of the protoplasm, itself.

Reproduction in the Presence of Various Concentrations of Tartaric Acid

Microscopic examination of tartaric-acid cultures was made seven days after the inoculum was transferred to the different solutions. An attempt was made to secure representative portions of the mycelium in order not to miss any of the spore types, because sometimes it so happens that not all of the spores can be found together in any one region. Furthermore, when reproduction is very sparse, it becomes necessary to examine quite a bit of the mycelial mass in order to ascertain the abundance of the different spore forms.

The writer does not accept spore production as a dependable specific character; the growth factor, being more stable, should be of greater service in physiological taxonomy. However, the effect of tartaric acid upon reproduction in Fusaria presents some interesting biological phenomenon as can be seen in the following tables.

The foregoing table suggests the following generalization: Of the three types of asexual sporulation in the genus Fusarium, chlamydospore production is the most easily inhibited by tartaric acid, and production of microconidia is inhibited the least. It can be speculatively stated that the degree of sensitivity to unfavorable external environments is indicative of the comparative age of these spores in the evolutionary life of Fusarium species.

F. asclerotium → 2 per cent tartaric acid = 0 → nutrient solution → agar
- → 0.75 per cent tartaric acid = V
- → 1 " " " " = IV
- → 1.5 " " " " = III
- → 2 " " " " = II

F. aquaeductuum pusilum → 0.75 per cent tartaric acid = 0 → nutrient solution → agar
- → 0.18 per cent tartaric acid = 0
- → 0.35 " " " " = 0
- → 0.75 " " " " = 0
- → 1 " " " " = 0

F. batatatis 1 → 1.5 per cent tartaric acid = 0 → nutrient solution → agar
- → 0.75 per cent tartaric acid = 0
- → 1 " " " " = 0
- → 1.5 " " " " = 0
- → 2 " " " " = 0

F. bullatum I → 1.5 per cent tartaric acid = 0 → nutrient solution → agar
- → 0.75 per cent tartaric acid = II
- → 1 " " " " = 0
- → 1.5 " " " " = 0
- → 2 " " " " = 0

F. chenopodinum → 0.37 per cent tartaric acid = 0 → nutrient solution → agar
- → 0.18 per cent tartaric acid = 0
- → 0.35 " " " " = 0
- → 0.75 " " " " = 0
- → 1 " " " " = 0

F. conglutinans → 1.5 per cent tartaric acid = 0 → nutrient solution → agar
- → 0.75 per cent tartaric acid = IV
- → 1 " " " " = III
- → 1.5 " " " " = III

F. cubense 1 → 1.5 per cent tartaric acid = 0 → nutrient solution → agar
- → 0.75 per cent tartaric acid = V
- → 1 " " " " = III
- → 1.5 " " " " = III
- → 2 " " " " = II

F. caudatum → 0.75 per cent tartaric acid = 0 → nutrient solution → agar
- → 0.18 per cent tartaric acid = IV
- → 0.35 " " " " = 0
- → 0.75 " " " " = 0
- → 1 " " " " = 0

F. camptoceras I → 0.75 per cent tartaric acid = III → agar
- → 0.18 per cent tartaric acid = V
- → 0.35 " " " " = V
- → 0.75 " " " " = 0

F. diversisporum I → 0.75 per cent tartaric acid = 0 → nutrient solution → agar → 0.18 per cent tartaric acid = V; → 0.35 " " " " = II; → 0.75 " " " " = 0; → 1 " " " " = 0

F. euoxysporum → 1.5 per cent tartaric acid = 0 → nutrient solution → agar → 0.75 per cent tartaric acid = III; → 1 " " " " = I; → 1.5 " " " " = 0; → 2 " " " " = 0

F. lycopersici 2 → 2 per cent tartaric acid = 0 → nutrient solution → agar → 1 per cent tartaric acid = V; → 1.5 " " " " = IV; → 2 " " " " = II; → 3 " " " " = 0

F. lycopersici microsporum → 2 per cent tartaric acid = 0 → nutrient solution → agar → 1 per cent tartaric acid = III; → 1.5 " " " " = II; → 2 " " " " = 0; → 3 " " " " = 0

F. loncheceras microsporum → 3 per cent tartaric acid = 0 → nutrient solution → agar → 2 per cent tartaric acid = 0; → 3 " " " " = 0; → 4 " " " " = 0

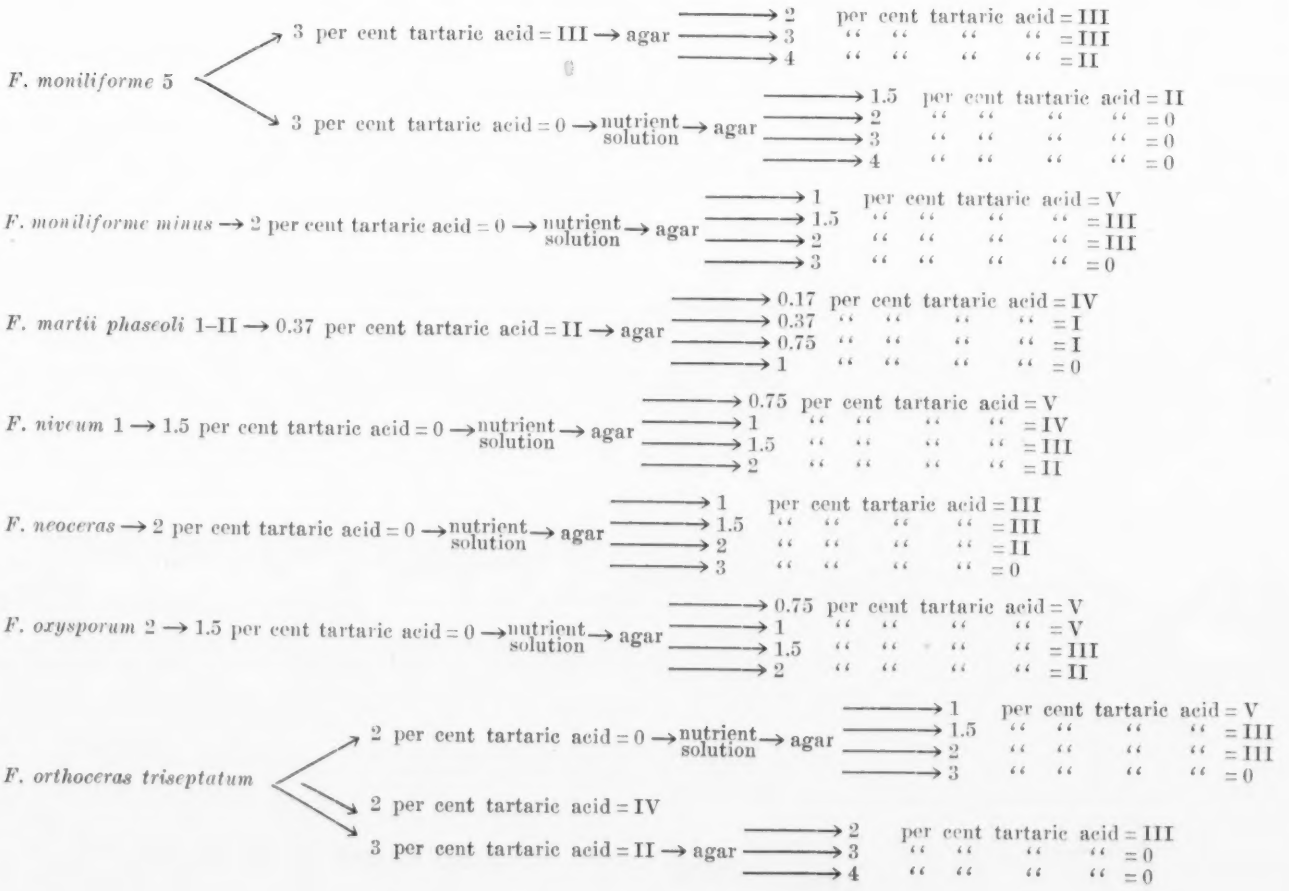
F. loncheceras → 2 per cent tartaric acid = 0 → nutrient solution → agar → 1 per cent tartaric acid = V; → 1.5 " " " " = III; → 2 " " " " = 0; → 3 " " " " = 0

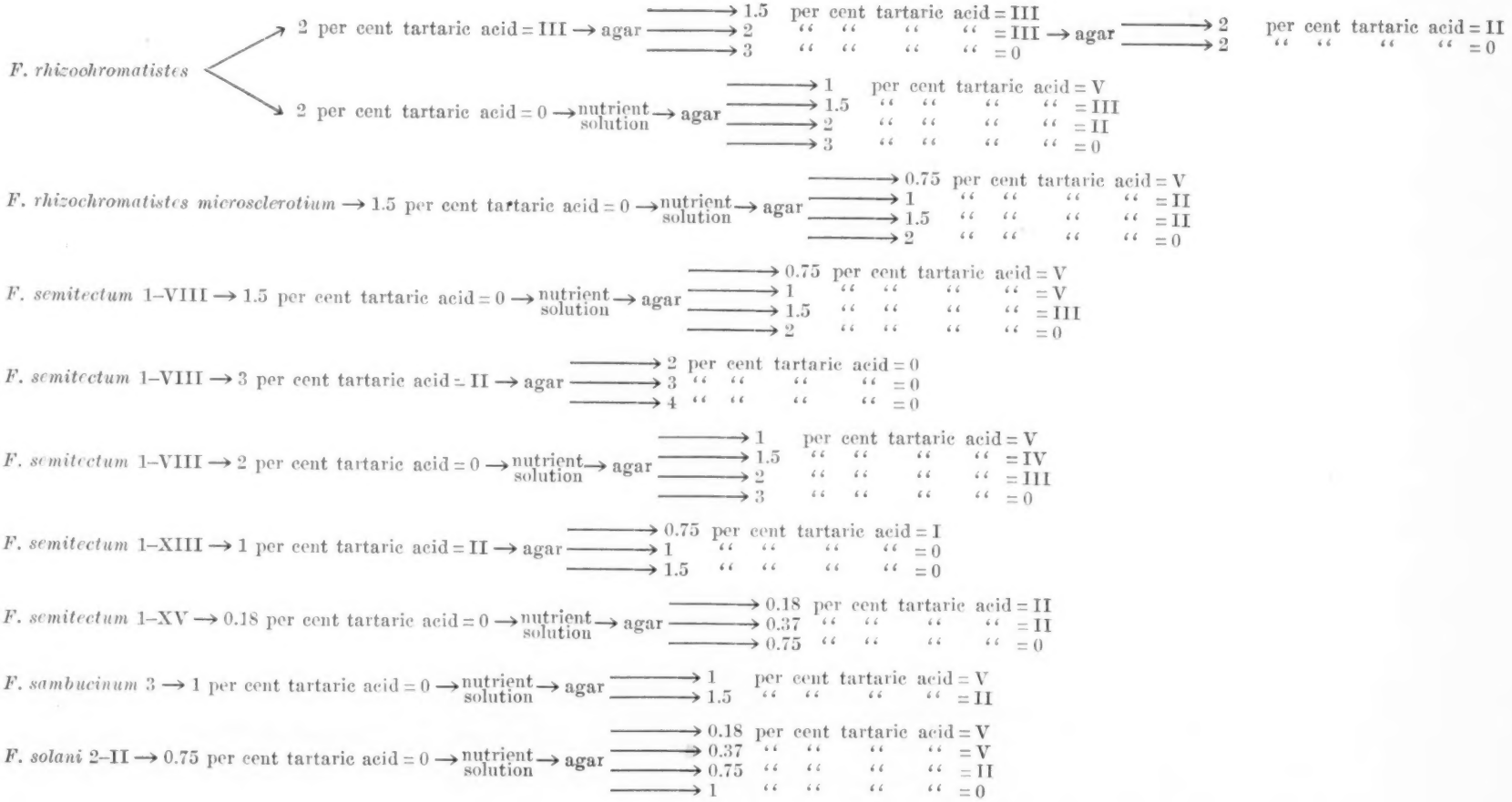
F. loncheceras → 2 per cent tartaric acid = II → agar → 1.5 per cent tartaric acid = III; → 2 " " " " = III; → 3 " " " " = 0

F. martii phaseoli 1–II → 0.18 per cent tartaric acid = 0 → nutrient solution → agar → 0.18 per cent tartaric acid = V; → 0.37 " " " " = II; → 0.75 " " " " = 0

F. moniliforme 4 → 2 per cent tartaric acid = III → agar → 1.5 per cent tartaric acid = IV; → 2 " " " " = III; → 3 " " " " = 0

F. moniliforme 4 → 2 per cent tartaric acid = 0 → nutrient solution → agar → 1 per cent tartaric acid = V; → 1.5 " " " " = IV; → 2 " " " " = 0; → 3 " " " " = 0


F. moniliforme 5
3 per cent tartaric acid = III → agar
→ 2 per cent tartaric acid = III
→ 3 " " " = III
→ 4 " " " = II
3 per cent tartaric acid = 0 → nutrient solution → agar
→ 1.5 per cent tartaric acid = II
→ 2 " " " = 0
→ 3 " " " = 0
→ 4 " " " = 0
F. moniliforme minus → 2 per cent tartaric acid = 0 → nutrient solution → agar
→ 1 per cent tartaric acid = V
→ 1.5 " " " = III
→ 2 " " " = III
→ 3 " " " = 0
F. martii phaseoli 1–II → 0.37 per cent tartaric acid = II → agar
→ 0.17 per cent tartaric acid = IV
→ 0.37 " " " = I
→ 0.75 " " " = I
→ 1 " " " = 0
F. nivcum 1 → 1.5 per cent tartaric acid = 0 → nutrient solution → agar
→ 0.75 per cent tartaric acid = V
→ 1 " " " = IV
→ 1.5 " " " = III
→ 2 " " " = II
F. neoceras → 2 per cent tartaric acid = 0 → nutrient solution → agar
→ 1 per cent tartaric acid = III
→ 1.5 " " " = III
→ 2 " " " = II
→ 3 " " " = 0
F. oxysporum 2 → 1.5 per cent tartaric acid = 0 → nutrient solution → agar
→ 0.75 per cent tartaric acid = V
→ 1 " " " = V
→ 1.5 " " " = III
→ 2 " " " = II
F. orthoceras triseptatum
2 per cent tartaric acid = 0 → nutrient solution → agar
→ 1 per cent tartaric acid = V
→ 1.5 " " " = III
→ 2 " " " = III
→ 3 " " " = 0
2 per cent tartaric acid = IV
3 per cent tartaric acid = II → agar
→ 2 per cent tartaric acid = III
→ 3 " " " = 0
→ 4 " " " = 0


F. rhizochromatistes
2 per cent tartaric acid = III → agar
→ 1.5 per cent tartaric acid = III
→ 2 " " " " = III → agar
→ 3 " " " " = 0
→ 2 per cent tartaric acid = II
→ 2 " " " " = 0
2 per cent tartaric acid = 0 → nutrient solution → agar
→ 1 per cent tartaric acid = V
→ 1.5 " " " " = III
→ 2 " " " " = II
→ 3 " " " " = 0
F. rhizochromatistes microsclerotium → 1.5 per cent tartaric acid = 0 → nutrient solution → agar
→ 0.75 per cent tartaric acid = V
→ 1 " " " " = II
→ 1.5 " " " " = II
→ 2 " " " " = 0
F. semitectum 1–VIII → 1.5 per cent tartaric acid = 0 → nutrient solution → agar
→ 0.75 per cent tartaric acid = V
→ 1 " " " " = V
→ 1.5 " " " " = III
→ 2 " " " " = 0
F. semitectum 1–VIII → 3 per cent tartaric acid = II → agar
→ 2 per cent tartaric acid = 0
→ 3 " " " " = 0
→ 4 " " " " = 0
F. semitectum 1–VIII → 2 per cent tartaric acid = 0 → nutrient solution → agar
→ 1 per cent tartaric acid = V
→ 1.5 " " " " = IV
→ 2 " " " " = III
→ 3 " " " " = 0
F. semitectum 1–XIII → 1 per cent tartaric acid = II → agar
→ 0.75 per cent tartaric acid = I
→ 1 " " " " = 0
→ 1.5 " " " " = 0
F. semitectum 1–XV → 0.18 per cent tartaric acid = 0 → nutrient solution → agar
→ 0.18 per cent tartaric acid = II
→ 0.37 " " " " = II
→ 0.75 " " " " = 0
F. sambucinum 3 → 1 per cent tartaric acid = 0 → nutrient solution → agar
→ 1 per cent tartaric acid = V
→ 1.5 " " " " = II
F. solani 2–II → 0.75 per cent tartaric acid = 0 → nutrient solution → agar
→ 0.18 per cent tartaric acid = V
→ 0.37 " " " " = V
→ 0.75 " " " " = II
→ 1 " " " " = 0

F. solani 3–III → 0.75 per cent tartaric acid = II → agar
- → 0.37 per cent tartaric acid = 0
- → 0.75 " " " " = 0
- → 1 " " " " = 0

F. solani 3–III → 0.37 per cent trataric acid = 0 → nutrient solution → agar
- → 0.18 per cent tartaric acid = V
- → 0.37 " " " " = V
- → 0.75 " " " " = 0

F. solani 4–I
- 0.18 per cent tartaric acid = II → agar
  - → 0.18 per cent tartaric acid = 0
  - → 0.37 " " " " = II
  - → 0.75 " " " " = 0
- 0.18 per cent tartaric acid = 0 → nutrient solution → agar
  - → 0.18 per cent tartaric acid = I
  - → 0.18 " " " " = V

F. tricinctum 1–VII → 0.18 per cent tartaric acid = 0 → nutrient solution → agar
- → 0.18 per cent tartaric acid = IV
- → 0.37 " " " " = II
- → 0.75 " " " " = 0

F. viride 2 → 2 per cent tartaric acid = 0 → nutrient solution → agar
- → 1 per cent tartaric acid = V
- → 1.5 " " " " = V
- → 2 " " " " = III
- → 3 " " " " = I

F. zonatum 2 → 1.5 per cent tartaric acid = 0 → nutrient solution → agar
- → 0.75 per cent tartaric acid = III
- → 1 " " " " = III
- → 1.5 " " " " = II
- → 2 " " " " = 0

F. zonatum 3 → 2 per cent tartaric acid = 0 → nutrient solution → agar
- → 1 per cent tartaric acid = III
- → 1.5 " " " " = III
- → 2 " " " " = 0
- → 3 " " " " = 0

TABLE 7.—*Reproduction in the presence of various concentrations of tartaric acid. 0.18%–1.5%*[10]

Organism	.18%			.37%			.75%			1%			1.5%		
	Mic.	Mac.	Chl.	Mic.	Mac.	Chl.	Mic.	Mac.	Chl.	Mic.	Mac.	Chl.	Mic.	Mac.	Chl.
F. acuminatum 2–III	II	III	0	I	II	0	0	0	0	0	0	0	0	0	0
F. acuminatum 2–IV	0	I	0	0	0	0	0	0	0	0	0	0	0	0	0
F. acuminatum 2–VII	0	I	0	0	0	0	0	0	0	0	0	0	0	0	0
F. acuminatum 2–VIII	0	III	0	0	III	0	0	0	0	0	0	0	0	0	0
F. alluviale	II	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F. aquaeductuum pusilum	III	0	0	III	0	0	0–III	0	0	0–III	0	0	0–II	0	0
F. aquaeductuum volutum II	III	0	0	III	0	0	III	0	0	II	0	0	II	0	0
F. asclerotium	III	0	0	III	0	0	III	0	0	III	0	0	III	0	0
F. aurantiacum	IV	I	III	IV	I	III	IV	0	0	IV	0	0	III	0	0
F. batatatis 1	IV	0	0	IV	0	0	IV	0	0	0	0	0	0	0	0
F. batatatis 2	IV	II	0	IV	II	0	IV	II	0	III	0	0	III	0	0
F. bulbigenum	V	II	III	V	0	III	V	0	III	IV	0	0	IV	0	0
F. bullatum I	I	IV	0	0	III	0	0	0	0	0	0	0	0	0	0
F. bullatum brevius	III	III	0	III	III	0	0	0	0	0	0	0	0	0	0
F. camptoceras I	II	IV	0	0	0	0	0	0	0	0	0	0	0	0	0
F. camptoceras II	I	III	0	0	0	0	0	0	0	0	0	0	0	0	0
F. caudatum	I	I	0	I	I	0	0	0	0	0	0	0	0	0	0
F. chenopodinum	II	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F. coeruleum 2	III	I	0	0	0	0	0	0	0	0	0	0	0	0	0
F. conglutinans	III	0	0	III	0	0	II	0	0	II	0	0	0	0	0
F. cubense 1	IV	III	III	IV	II	III	IV	II	0	IV	II	0	0	0	0
F. cubense 2	III	0	0	III	0	0	II	0	0	0	0	0	0	0	0
F. culmorum 3–I	0	IV	0	0	0	0	0	0	0	0	0	0	0	0	0
F. culmorum 6–I	IV	II	II	III	II	II	III	I	I	III	0	0	0	0	0
F. diversisporum I	0–II	IV	0	0–II	IV	0	0	0	0	0	0	0	0	0	0
F. diversisporum II	I–IV	0–II	0	0–IV	0–II	0	0–IV	0–II	0	0	0	0	0	0	0
F. cumartii 1–II	0–III	0–0	0–0	0	0	0	0	0	0	0	0	0	0	0	0
F. euoxysporum	III	II	0	II	II	0	0	0	0	0	0	0	0	0	0
F. filiferum II	0–0	0–IV	0–0	0	0	0	0	0	0	0	0	0	0	0	0
F. fructigenum 2	IV	0	0	IV	0	0	IV	0	0	III	0	0	0	0	0
F. fructigenum maius 1	I	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F. fructigenum maius 2–V	0	V	0	0–0	I–III	0–0	0	0	0	0	0	0	0	0	0

[10] Only those organisms which formed spores in the presence of tartaric acid have been included in this and the next table.

TABLE 7.—(*Continued*)

Organism	.18%			.37%			.75%			1%			1.5%		
	Mic.	Mac.	Chl.	Mic.	Mac.	Chl.	Mic.	Mac.	Chl.	Mic.	Mac.	Chl.	Mic.	Mac.	Chl.
F. fructigenum maius 3–III	0	II	0	0	0	0	0	0	0	0	0	0	0	0	0
F. gemmiperda	IV	II	0	IV	II	0	IV	0	0	IV	0	0	III	0	0
F. gibbosum	III	II	II	III	0	0	III	0	0	0	0	0	0	0	0
F. graminum 2–II	I	IV	0	I	III	0	0	0	0	0	0	0	0	0	0
F. herbarum gibberalloides I	II	0	0	I	0	0	I	0	0	0	0	0	0	0	0
F. herbarum gibberalloides II	III	II	0	III	II	0	0	0	0	0	0	0	0	0	0
F. hyperoxysporum 1	V	IV	IV	V	IV	IV	IV	IV	0	IV	IV	0	III	0	0
F. hyperoxysporum 2	IV	III	0	IV	III	0	IV	II	0	III	0	0	0	0	0
F. incarnatum I	II	IV	0	0	0	0	0	0	0	0	0	0	0	0	0
F. incarnatum II	II	IV	0	II	III	0	II	III	0	0	0	0	0	0	0
F. incarnatum IV	II	IV	0	II	IV	0	II	II	0	0	0	0	0	0	0
F. incarnatum V	II	IV	0	II	IV	0	0	0	0	0	0	0	0	0	0
F. javanicum 1	II	I	III	0	0	0	0	0	0	0	0	0	0	0	0
F. javanicum 2	V	0	II	V	0	II	V	0	0	III	0	0	II	0	0
F. loncheceras	III	0	0	III	0	0	III	0	0	III	0	0	III	0	0
F. lutulatum I	IV	IV	0	IV	IV	0	IV	IV	0	IV	III	0	III	0	0
F. lutulatum II	III	V	0	III	V	0	III	IV	0	III	III	0	III	II	0
F. lycopersici 2	III	II	0	III	I	0	III	0	0	III	0	0	II	0	0
F. malli	II	0	0	II	0	0	II	0	0	0	0	0	0	0	0
F. macroceras	0	II	0	0	0	0	0	0	0	0	0	0	0	0	0
F. martii 1	III	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F. martii 2	IV	0	I	IV	0	I	III	0	0	III	0	0	II	0	0
F. martii 3–II	0–III	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F. martii phaseoli 1–II	0–IV	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F. martii pisi	V	III	0	V	III	0	III	0	0	0	0	0	0	0	0
F. moniliforme 1	IV	0	0	IV	0	0	IV	0	0	IV	0	0	IV	0	0
F. moniliforme 2	IV	0	0	IV	0	0	IV	0	0	IV	0	0	III	0	0
F. moniliforme 5	IV	0	0	IV	0	0	IV	0	0	IV	0	0	IV	0	0
F. moniliforme erumpens I	III	0	0	III	0	0	III	0	0	III	0	0	II	0	0
F. moniliforme erumpens II	IV	0	0	IV	0	0	IV	0	0	IV	0	0	IV	0	0
F. moniliforme minus	IV	I	0	IV	0	0	IV	0	0	IV	0	0	II	0	0
F. moniliforme subglutinans	III	0	0	III	0	0	III	0	0	III	0	0	II	0	0
F. neoceras	III	0	0	III	0	0	III	0	0	III	0	0	III	0	0

TABLE 7.—(*Continued*)

Organism	.18%			.37%			.75%			1%			1.5%		
	Mic.	Mac.	Chl.	Mic.	Mac.	Chl.	Mic.	Mac.	Chl.	Mic.	Mac.	Chl.	Mic.	Mac.	Chl.
F. nivcum 1	III	III	II	III	II	II	III	II	0	II	0	0	0	0	0
F. nivcum 2	II	0	0	II	0	0	0	0	0	0	0	0	0	0	0
F. orthoceras trisceptatum	III	0	III	III	0	III	III	0	III	III	0	0	II	0	0
F. ossicolum 1	V	I	0	IV	I	0	IV	0	0	IV	0	0	IV	0	0
F. ossicolum 2	III	IV	0	I	II	0	0	0	0	0	0	0	0	0	0
F. oxysporum 1	II	I	III	II	0	II	II	0	0	II	0	0	0	0	0
F. oxysporum 2	V	0	II	V	0	0	IV	0	0	IV	0	0	IV	0	0
F. oxysporum nicotianae	IV	0	II	IV	0	II	IV	0	0	IV	0	0	0	0	0
F. pirinum	II	II	0	II	II	0	0	0	0	0	0	0	0	0	0
F. rhizochromatistes	V	II	III	V	II	I	IV	0	0	III	0	0	III	0	0
F. rhizochromatistes-microsclerotium	IV	0	0	III	0	0	III	0	0	0	0	0	0	0	0
F. sambucinum 2	III	0	0	III	0	0	0	0	0	0	0	0	0	0	0
F. sclerostromaton	III	II	II	III	II	0	III	0	0	II	0	0	II	0	0
F. semitectum 1–I	IV	IV	I–0	II	II	0	0	0	0	0	0	0	0	0	0
F. semitectum 1–II	IV	III	0	III	III	0	II	II	0	0	0	0	0	0	0
F. semitectum 1–III	IV	IV	0	III	III	0	II	II	0	0	0	0	0	0	0
F. semitectum 1–IV	I	I	0	I	I	0	I	0	0	0	0	0	0	0	0
F. semitectum 1–VI	III	II	0	II	II	0	II	I	0	0	0	0	0	0	0
F. semitectum 1–VIII	V	III	II	IV	III	II	IV	II	II	III	0	0	III	0	0
F. semitectum 1–X	III	IV	0	III	IV	0	0	0	0	0	0	0	0	0	0
F. semitectum 1–XI	IV	III	0	0–IV	0–III	0	0	0	0	0	0	0	0	0	0
F. semitectum 1–XII	II–IV	II–IV	0–0	II–III	II–II	0–0	0	0	0	0	0	0	0	0	0
F. semitectum 1–XIII	II–IV	II–IV	0–0	II–III	II–II	0–0	0	0	0	0	0	0	0	0	0
F. semitectum 1–XVII	II	III	0	I	II	0	0	0	0	0	0	0	0	0	0
F. semitectum 2	II	IV	0	II	III	0	0	0	0	0	0	0	0	0	0
F. solani 1	I	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F. solani 2–I	V	0	0	V	0	0	IV	0	0	II	0	0	0	0	0
F. solani 2–II	V	III	II	V	III	II	III	I	I	II	0	0	0	0	0
F. solani 3–I	IV	IV	0	III	0	0	0	0	0	0	0	0	0	0	0
F. solani 3–II	IV	II	0	IV	0	0	0	0	0	0	0	0	0	0	0
F. solani 3–III	III	II	III	III	0	0	0	0	0	0	0	0	0	0	0
F. solani 4–I	0–II	0–0	0–0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 7.—(*Continued*)

Organism	.18%			.37%			.75%			1%			1.5%		
	Mic.	Mac.	Chl.	Mic.	Mac.	Chl.	Mic.	Mac.	Chl.	Mic.	Mac.	Chl.	Mic.	Mac.	Chl.
F. solani 4–II	III	V	0	III	0	0	0	0	0	0	0	0	0	0	0
F. solani minus 1–I	0–V	0–0	0–0	0–IV	0–0	0–0	0	0	0	0	0	0	0	0	0
F. solani minus 1–II	II	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F. solani minus 2–I	IV	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F. solani minus 2–II	I	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F. spinaceae 1	IV	III	III	IV	III	III	IV	III	0	III	III	0	0	0	0
F. spinaceae 2	IV	III	III	IV	III	III	IV	III	III	IV	III	0	II	0	0
F. striatum 3–I	III	II	0	0	0	0	0	0	0	0	0	0	0	0	0
F. striatum 3–II	0–III	0–III	0–0	0	0	0	0	0	0	0	0	0	0	0	0
F. sulphureum 2	I	III	0	0	0	0	0	0	0	0	0	0	0	0	0
F. sulphureum 3	0	III	0	0	I	0	0	0	0	0	0	0	0	0	0
F. theobrome	II	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F. tracheiphilum	V	0	0	V	0	0	V	0	0	V	0	0	0	0	0
F. trichothecioides 1–I	I	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F. trichothecioides 2–II	0	III	0	0	0	0	0	0	0	0	0	0	0	0	0
F. trichothecioides 3–I	I	III	0	0	0	0	0	0	0	0	0	0	0	0	0
F. trichothecioides 4–II	0–0	0–V	0–0	0–0	0–V	0–0	0	0	0	0	0	0	0	0	0
F. trichothecioides 5	V	0	0	V	0	0	IV	0	0	III	0	0	0	0	0
F. trichothecioides 6	IV	II	0	IV	II	0	IV	II	0	IV	II	0	II	0	0
F. trichothecioides 7–II	0–II	0–I	0–0	0	0	0	0	0	0	0	0	0	0	0	0
F. tricinctum 1–III	III	III	I	III	I	0	0	0	0	0	0	0	0	0	0
F. tricinctum 1–IV	III	0	0	III	0	0	0	0	0	0	0	0	0	0	0
F. tricinctum 1–V	III	II	0	III	0	0	0	0	0	0	0	0	0	0	0
F. tricinctum 1–VI	III–V	0–II	0–0	0–V	0–II	0–0	0–V	0–II	0–0	0	0	0	0	0	0
F. tricinctum 1–VII	0–IV	0–II	0–0	0	0	0	0	0	0	0	0	0	0	0	0
F. tricinctum 1–IX	III	II	0	0	0	0	0	0	0	0	0	0	0	0	0
F. tricinctum 2	II	II	0	0	0	0	0	0	0	0	0	0	0	0	0
F. uncinatum	IV	III	0	IV	III	0	III	II	0	III	0	0	0	0	0
F. urticearum I	0–II	0–V	0–0	0	0	0	0	0	0	0	0	0	0	0	0
F. vasinfectum	II	IV	IV	II	IV	0	II	IV	0	II	IV	0	0	0	0
F. viride 1	II	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F. viride 2	V	0	III	V	0	III	V	0	0	V	0	0	IV	0	0
F. viticola	II	IV	0	0	0	0	0	0	0	0	0	0	0	0	0
F. zonatum 2	III	IV	IV	III	IV	0	III	III	0	III	III	0	0	0	0
F. zonatum 3	IV	IV	0	IV	IV	0	IV	IV	0	IV	III	0	III	I	0

TABLE 7.—(*Continued.*)—*Reproduction in presence of various amounts of tartaric acid (2–5 per cent)*

Organism	2%			3%		
	Mic.	Mac.	Chl.	Mic.	Mac.	Chl.
F. aquaeductuum pusilum	0–II	0	0	0	0	0
F. asclerotium	0	0	0	0	0	0
F. aurantiacum	0	0	0	0	0	0
F. batatatis 2	II	0	0	0	0	0
F. bulbigenum	0	0	0	0	0	0
F. hyperoxysporum 1	0	0	0	0	0	0
F. javanicum 2	0	0	0	0	0	0
F. loncheceras	0	0	0	0	0	0
F. lutulatum I	0	0	0	0	0	0
F. lutulatum II	0	0	0	0	0	0
F. lycopersici 2	0	0	0	0	0	0
F. martii 2	II	0	0	0	0	0
F. moniliforme 1	III	0	0	0	0	0
F. moniliforme 2	II	0	0	0	0	0
F. moniliforme 5	0	0	0	0	0	0
F. moniliforme erumpens I	II	0	0	0	0	0
F. moniliforme erumpens II	IV	0	0	II	0	0
F. moniliforme minus	II	0	0	0	0	0
F. moniliforme subglutinans	0	0	0	0	0	0
F. neoceras	I	0	0	0	0	0
F. orthoceras triseptatum	0	0	0	0	0	0
F. ossicolum 1	III	0	0	0	0	0
F. oxysporum 2	0	0	0	0	0	0
F. rhizochromatistes	0	0	0	0	0	0
F. sclerostromaton	0	0	0	0	0	0
F. semitectum 1–VIII	II	I	0	0	0	0
F. spinaceae 2	0	0	0	0	0	0
F. trichothecioides 6	0	0	0	0	0	0
F. viride 2	0	0	0	0	0	0
F. zonatum 3	0	0	0	0	0	0

GROWTH IN PRESENCE OF VARIOUS AMOUNTS OF MALACHITE GREEN

The toxicity of aniline dyes has been commonly known for quite a long time and their use in medicine has reached an important stage of development. Malachite green[11] has been used both in this country and in Europe with different degrees of effectiveness in the control of micro-organisms.

About 50 different dyes and indicators were tested to find one that would yield the best differential growth. The dyes which have given such excellent results in medicine, such as gentian violet, acroflavin, acroviolet, and some others, failed to exert a marked inhibitory effect when used in as high concentrations as 0.1 per cent. Malachite green, on the other hand, although

[11] After this paper was submitted to the Editor the writer saw a paper by G. H. Coons (Plant pathology and physiology in relation to man, Mayo Foundation Lectures 1926–27. Some aspects of the Fusarium problem, p. 43–92) in which malachite green is shown to exert a decidedly toxic influence upon a number of Fusarium species. 1: 40,000 malachite green was the most dilute solution used.

unable to retard bacterial growth, exerted a remarkable effect upon Fusaria even in extremely dilute quantities.

Six different concentrations of malachite green, varying from 0.0002 per cent to 0.01 per cent, have been used in these experiments. The nutrient solution to which the dye was added was prepared according to the following formula: Potassium nitrate, 2 grams; Dihydrogen potassium phosphate, 1 gram; Magnesium sulphate, 1 gram; Dextrose, 10 grams; Distilled water, 1,000 c.c. Unless otherwise stated, this solution has been used in all of the remaining experiments.

Readings were made two weeks after the transfer of the inoculum into the solutions and the results are presented in the following table:

Eleven organisms failed to grow when malachite green was present in such minute concentrations as 0.0002 per cent and a number of others made only a poor growth. In the presence of 0.0005 per cent of this dye, the number of organisms which failed to grow was increased to more than forty, while many others grew very slightly or sporadically. When the concentration of malachite green was increased to 0.004 per cent, only twenty-eight organisms made any sort of growth, most of them sporadic and hardly discernible. Only three organisms were able, occasionally, to withstand the influence of a concentration of 0.01 per cent of this dye.

Some striking dissimilarities are to be noticed in the reaction of strains of the same species towards the effect of malachite green. *F. culmorum* 1–II makes no growth in the presence of 0.0005 per cent malachite green, while no. 6–II tolerates as much as 0.004 per cent. The other strains of this species show more or less pronounced differences. One can not but wonder if such sharp dissimilarities do not indicate that the specific characters whereby the members of this group are thrown together, may not be rather vague or imperfect. *F. moniliforme* 3 is the only member of this species that is highly sensitive to malachite green. *F. semitectum* 1–VIII is the only one of the nineteen strains of this species able to tolerate 0.002 per cent of the dye, while no. 1–IX and 1–XIV are the only ones unable to grow in the presence of 0.0002 per cent of malachite green. *F. trichothecioides* 3–I and 7–II do not grow when there is more than 0.0002 per cent of the dye present, whereas *F. trichothecioides* 2–II and 7–I grow even when the concentration is increased to 0.002 per cent. *F. tricinctum* 2 seems to have more tolerance for the dye than the eight strains of *F. tricinctum* 1.

Generally speaking, however, there is more similarity of reaction toward malachite green than there is of dissimilarity, as even a casual glance at the foregoing table will reveal. Nevertheless, the same lack of uniformity which has characterized the reactions of Fusaria toward other environmental factors is to be noted in the following graphical matter:

TABLE 8.—*Growth in presence of various concentrations of Malachite Green (2 weeks at 25° C.)*

Organism	0.0002%	0.0005%	0.001%	0.002%	0.004%	0.01%
F. acuminatum 1	V–V	0–0–V–0	0–0	0–0	0–0	0–0
F. acuminatum 2–I	III–IV–III–IV	0–0–0–0	0–0	0–0	0–0	0–0
F. acuminatum 2–II	II–0–III–IV	0–0–0–0	0–0	0–0	0–0	0–0
F. acuminatum 2–III	IV–IV–IV–V	IV–0–III–IV	0–0	0–0	0–0	0–0
F. acuminatum 2–IV	IV–V–V–V	0–II–0–0	0–I–0	0–0	0–0	0
F. acuminatum 2–V	IV–V–III–IV	0–0–III–III	0–0	0–0	0–0	0
F. acuminatum 2–VI	V–V–IV–IV	I–I–II–III	0–0	0–0	0–0	0
F. acuminatum 2–VII	III–IV–IV–IV	II–IV–IV–IV	IV–I–0	I–0–0	0–0	0
F. acuminatum 2–VIII	IV–IV–V–IV	II–0–IV–IV	0–0	0–0	0–0	0
F. alluviale	V	V–V	III–III	0–0	0	0
F. anthophilum	0–I–I	0–0–0–0	0–0	0–0	0–0	0
F. aquaeductuum pusilum	V–V	V–V	0–III	0–0	0–0	0
F. aquaeductuum volutum	V	IV–IV	I–III	0–II–0	0–0	0
F. arcuatum	0–0	0–0–0	0–0	0–0	0–0	0
F. asclerotium	V	V–V	IV–IV	III–IV	III–0–0	0–0
F. aurantiacum	V	V–V	IV–IV	II–I	0–0	0
F. avenaceum	III–IV	I–0	0–0	0–0	0–0	0
F. batatatis 1	V	V	III–IV	0–0	0–0	0
F. batatatis 2	V	V	III–III	0–0	0–0	0
F. bulbigenum	V	V	IV–IV	III–I	III–0–0	0
F. bullatum I	III	II	0–0	0–0	0–0	0
F. bullatum II	IV	III	II–0–0	0–0	0–0	0
F. bullatum brevius	I–0–III–III	I–0–I–I	0–0	0–0	0–0	0
F. camptoceras I	IV	III	II–II	I–I	0–0	0
F. camptoceras II	V	V	II–0–III	II–0–II	I–0–II	I–0
F. caudatum	IV	III	0–I–0–0	0–0	0–0	0
F. chlamydosporum I	I–I	0–0	0–0	0–0	0–0	0
F. chlamydosporum II	II–II	0–0	0–0	0–0	0–0	0
F. chlamydosporum III	I–I	0–0	0–0	0–0	0–0	0
F. chenopodinum	III–V	0–0	0–0	0–0	0–0	0
F. coeruleum 1–I	III–II	II	0–0	0–0	0–0	0
F. coeruleum 1–II	V	V	0–0	0–0	0–0	0
F. coerulum 2	V–V	0–II	0–0	0–0	0–0	0
F. coeruleum 3	II–II	0–0–0	0–0	0–0	0–0	0
F. commutatum	II–II	0–0	0–0	0–0	0–0	0

TABLE 8.—(*Continued*)

Organism	0.0002%	0.0005%	0.001%	0.002%	0.004%	0.01%
F. conglutinans	V	V	III–IV	0–III	0–0–III	0–0
F. cubense 1	V	V	IV–III	III–0–III	II–0–0	0–0
F. cubense 2	III–IV	I–0	0–0	0–0	0–0	0
F. culmorum 1–I	V–V	II–0	I–0–0	0–0	0–0	0
F. culmorum 1–II	V–V	0–0	0–0	0–0	0–0	0
F. culmorum 2	V	V	IV–IV	0–IV–0	0–I–0	0–0
F. culmorum 3–I	IV–IV–V–V	IV–0–V–V	III–III	II–III	0–0	0
F. culmorum 3–II	V–V–IV–V	V–0–IV–IV	III–I–0	0–0–0	0–0	0
F. culmorum 4–I	V	IV	III–IV	0–0	0–0	0
F. culmorum 4–II	V	IV	0–II–II	0–II–0	0–I–0	0–0
F. culmorum 5	V–V	0–IV–IV	II–0–0	0–0	0–0	0
F. culmorum 6–I	V	V	III–IV	III–III	0–0	0
F. culmorum 6–II	V	V	IV–IV	IV–IV	II–II	0–0
F. decemcellulare	V	IV	I–III–III	I–II–II	0–0	0
F. dimerum	V	V	V–V	IV–V	I–IV–0	0–0
F. diversisporum	V–V	0–0	0–0	0–0	0–0	0
F. ensiforme	0–0–0–0	0–0–0–0	0–0	0–0	0–0	0
F. eumartii 1–I	V	V	II–II	0–I–0	0–0	0
F. eumartii 1–II	V	V	I–IV	0–II–II	0–0	0
F. eumartii 2–I	V	IV	I–I	0–0	0–0	0
F. eumartii 2–II	V	III	0–0	0–0	0–0	0
F. eumartii 3	V–V	II–0	0–0	0–0	0–0	0
F. euoxysporum	V	V	III–IV	II–III	0–0	0
F. falcatum	IV–IV–IV	III–0–0	0–0	0–0	0–0	0
F. filiferum I	V	V	II–II	0–0	0–0	0
F. filiferum II	V	V	I–0–0	I–0–0	0–0	0
F. flocciferum	V–V	V–0	0–0	0–0	0–0	0
F. fructigenum	0–0–0–0	0–0–0–0	0–0	0–0	0–0	0
F. fructigenum maius 1	V	V	0–I–I	0–0	0–0	0
F. fructigenum maius 2–I	IV–V–V	III–IV–V	II–II	I–II	0–0	0
F. fructigenum maius 2–II	V–V	III–IV	III–III	II–II	0–0	0
F. fructigenum maius 2–III	V–V	IV–II	I–I	0–0	0–0	0
F. fructigenum maius 2–IV	IV–V	IV–III	III–III	II–II	0–0	0
F. fructigenum maius 2–V	V–V	II–V	0–0	0–0	0–0	0
F. fructigenum maius 2–VII	V–V	II–II	0–0	0–0	0–0	0

TABLE 8.—(*Continued*)

Organism	0.0002%	0.0005%	0.001%	0.002%	0.004%	0.01%
F. fructigenum maius 2–VIII	V–V	II–IV	0–0–I	0–0	0–0	0
F. fructigenum maius 3–I	V	V	III–I–IV	I–0–0	0–0	0
F. fructigenum maius 3–II	IV	III	II–III	0–0	0–0	0
F. fructigenum maius 3–III	V–V	IV–0	III–IV	0–0	0–0	0
F. gibbosum	IV	III	0–0	0–0	0–0	0
F. graminum 1	V	V	III–II	II–0	0–0	0
F. graminum 2–I	III–IV	0–0	0–0	0–0	0–0	0
F. graminum 2–II	IV–IV	0–0	0–0	0–0	0–0	0
F. herbarum 1	IV	III	III–I	0–0	0–0	0
F. herbarum 2	V–V	II–0	0–0	0–0	0–0	0
F. herbarum gibberalloides I	IV–IV	II–0	0–0	0–0	0–0	0
F. herbarum gibberalloides II	IV–IV–IV	II–III–III	0–0	0–0	0–0	0
F. herbarum pirinum I	0–I–0–0–0	0–0–0–0	0–0	0–0	0–0	0
F. herbarum pirinum II	0–0–0–0–0	0–0–0–0	0–0	0–0	0–0	0
F. hyperoxysporum 1	V	V	IV–III	III–0	III–0	0
F. hyperoxysporum 2	V–V–V	V–IV–V	III–IV	0–0	0–0	0
F. incarnatum I	V	IV	I–0–0	0–0	0–0	0
F. incarnatum II	V–IV	V–0	0–0	0–0	0–0	0
F. incarnatum IV	IV	III	II–0–0	0–0	0–0	0
F. incarnatum V	IV	III	0–II–0	0–0	0–0	0
F. javanicum 1	V	V	IV–V	III–III	0–0	0
F. javanicum 2	IV	III	III–III	III–I	0–0	0
F. lateritium I	0–0–0–0	0–0–0–0	0–0	0–0	0–0	0
F. lateritium II	0–0–0–0	0–0–0–0	0–0	0–0	0–0	0
F. lini	V	V	III–III	II–0–0	0–0	0
F. lolii	0–0	0–0–0	0–0	0–0	0–0	0
F. loncheceras	V	V	III–II	II–0	I–0–0	0–0
F. loncheceras microsporum	V	V	II–IV	0–0	0–0	0
F. longipes	0–II–III–III	0–0–0–0	0–0	0–0	0–0	0
F. lutulatum I	IV	III	II–III	I–I	0–0	0
F. lutulatum II	IV	IV	IV–III	III–II	0–0	0
F. lycopersici 1	V	IV	II–II	0–0	0–0	0
F. lycopersici 2	V	V	II–I	0–0	0–0	0
F. malli	IV	III	II–II	0–I	0–0	0
F. macroceras	V	V	III–II	0–0	0–0	0

TABLE 8.—(*Continued*)

Organism	0.0002%	0.0005%	0.001%	0.002%	0.004%	0.01%
F. martii 1	V	V	V–V–0	IV–V–0	II–III–0	0
F. martii 2	V	V	III–III	III–0–V	0–0	0
F. martii 3–I	V	V	IV–IV	III–II	0–I–0	0
F. martii 3–II	V	V	IV–IV	III–II	0–0	0
F. martii minus	V–IV–V	V–IV–IV	IV–III	0–0	0–0	0
F. martii phaseoli 1–I	IV	IV	III–IV	0–III–0	0–III–0	0–II
F. martii phaseoli 1–II	V	V	IV–IV	III–III	0–I–0–0	0–0
F. martii phaseoli 1–III	IV	III	I–II	0–I–II	0–0	0
F. martii phaseoli 2–I	V–V–V	IV–V–V	I–I	0–0	0–0	0
F. martii phaseoli 2–II	V–V	II–IV–IV	I–I	0–0	0–0	0
F. martii pisi	IV	III	II–III	I–II	0–0	0
F. martii viride	V	V	III–V	III–IV	0–III–0	0–0
F. moniliforme 1	IV–IV–IV	III–IV–III	III–IV	0–III–I	0–0	0
F. moniliforme 2	V	V	IV–IV	II–III	0–II	0–0
F. moniliforme 3	0–0–I–II	0–0–0–0	0–0	0–0	0–0	0
F. moniliforme 4	V	V	III–III	0–0	0–0	0
F. moniliforme 5	IV	III	III–III	I–I	0–0	0
F. moniliforme erumpens I	V	V	III–IV	III–IV	0–0	0
F. moniliforme erumpens II	V	V	IV–IV	III–III	0–0	0
F. moniliforme minus	V–V–V	IV–IV–IV	III–IV	III–IV	0–III–0	0–0
F. moniliforme subglutinans	III–IV–III	III–II–III	0–II–0	0–0	0–0	0
F. neoceras	IV	III	I–I	0–0	0–0	0
F. niveum 1	V	V	0–III–0	0–0	0–0	0
F. niveum 2	V–V	III–0	0–II–0	0–0	0–0	0
F. orthoceras	V	V	III–III	II–I	0–0	0
F. orthoceras triseptatum	V	V	III–III	II–II	I–0–0	0–0
F. ossicolum 1	II–I	0–I–0–0	0–0	0–0	0–0	0
F. ossicolum 2	IV	III	III–III	0–0	0–0	0
F. oxysporum 1	IV	III	III–II	0–0	0–0	0
F. oxysporum 2	V	V	II–III	0–0	0–0	0
F. oxysporum nicotianae	V	V	II–IV	0–I–III	0–0	0
F. paspalicola	V	V	0–0	0–0	0–0	0
F. pirinum	III–IV–IV	II–III–IV	0–I–0	0–0	0–0	0
F. poae I	IV–V	II–III–III	0–0	0–0	0–0	0
F. poae II	V–V	IV–V–0–IV–V	0–0	0–0	0–0	0

TABLE 8.—(*Continued*)

Organism	0.0002%	0.0005%	0.001%	0.002%	0.004%	0.01%
F. polymorphum	III–II	0–0	0–0	0–0	0–0	0
F. pusillum	V	V	IV–IV	III–IV	II–0	0–0
F. radicicola	V	V	III–IV	0–III–V	0–I–0	0–0
F. rhizochromatistes	V	V	II–III	II–0–0	0–0	0
F. rhizochromatistes-microsclerotium	V	V	III–IV	II–III	0–0	0
F. sambucinum 1	0–0	0–0	0–0	0–0	0–0	0
F. sambucinum 2	IV–V–IV–IV	IV–III–III	III–III–0	0–0	0–0	0
F. scirpi	II–III	0–0	0–0	0–0	0–0	0
F. sclerostromaton	V	V	0–III–III	0–II–II	0–I–0	0
F. semitectum 1–I	0–I–II–II	0–0–0–0	0–0	0–0	0–0	0
F. semitectum 1–II	II–II	0–0	0–0	0–0	0–0	0
F. semitectum 1–III	III–IV	0–I	0–0	0–0	0–0	0
F. semitectum 1–IV	IV–IV	0–0	0–0	0–0	0–0	0
F. semitestum 1–V	V–V	0–0	0–0	0–0	0–0	0
F. semitectum 1–VI	V–V	I–I	0–0	0–0	0–0	0
F. semitectum 1–VII	II–II	0–0	0–0	0–0	0–0	0
F. semitectum 1–VIII	V–V	IV–V	III–III	II–II	0–I–0	0
F. semitectum 1–IX	0–0–I–I	0–0–0–0	0–0	0–0	0–0	0
F. semitectum 1–X	V–V	0–0	0–0	0–0	0–0	0
F. semitectum 1–XI	0–I–II–III	0–0–0–0	0–0	0–0	0–0	0
F. semitectum 1–XII	II–II	0–0	0–0	0–0	0–0	0
F. semitectum 1–XIII	III–IV	0–0	0–0	0–0	0–0	0
F. semitectum 1–XIV	0–0–0–0	0–0–0–0	0–0	0–0	0–0	0
F. semitectum 1–XV	II–II	0–0	0–0	0–0	0–0	0
F. semitectum 1–XVI	II–II	0–0	0–0	0–0	0–0	0
F. semitectum 1–XVII	V–V	0–II	0–0	0–0	0–0	0
F. semitectum 1–XVIII	IV–V	0–IV	0–0	0–0	0–0	0
F. semitectum 2	0–0–III–III	0–0–I–I	0–0	0–0	0–0	0
F. solani 1	V	V	III–V	0–V–0–V	0–IV–0	0–0
F. solani 2–I	V	V	III–III	I–II	0–0	0
F. solani 2–II	V	V	IV–V	III–V	III–IV	0–0
F. solani 3–I	V	V	III–IV	III–IV	0–0	0
F. solani 3–II	V	V	IV–IV	III–III	0–0	0
F. solani 3–III	V	V	IV–IV	III–III	0–0	0

TABLE 8.—(*Continued*)

Organism	0.0002%	0.0005%	0.001%	0.002%	0.004%	0.01%
F. solani 4–I	V	V	IV–IV	II–IV	0–0	0
F. solani 4–II	V	V	IV–I	II–IV–V	0–0	0
F. solani minus 1–I	V	V	IV–IV	III–II	II–II	0–0
F. solani minus 1–II	V	V	IV–III	II–0–0	0–0	0
F. solani minus 2–I	V	V	IV–V	IV–IV	III–III–0	III–0
F. solani minus 2–II	V	V	V–IV	IV–IV	0–0	0
F. solani suffuscum	V	V	II–IV	0–0	0–0	0
F. spinaceae 1	V	V	III–III	III–II	0–0	0
F. spinaceae 2	V	V	III–IV	II–II	0–0	0
F. striatum 1–I	V	V	IV–III	II–0–0	0–0	0
F. striatum 1–II	V	V	II–IV	II–III	0–0	0
F. striatum 2	V	V	III–V	III–V	II–III	0–0
F. striatum 3–I	V	V	IV–IV	IV–IV	0–III–IV	0–0
F. striatum 3–II	V	V	IV–V	IV–IV	0–0	0
F. sulphureum 1	V	V	I–0–V	0–0	0–0	0
F. sulphureum 2	II–II	I–0	I–0–0	0–0–0	0–0	0
F. sulphureum 3	IV	III	II–III	I–I	0–0	0
F. theobrome	V	V	III–III	0–0	0–0	0
F. tracheiphilum	IV	III	II–II	0–0	0–0	0
F. trichothecioides 1	0–0–III–IV	0–0–I–0	0–0	0–0	0–0	0
F. trichothecioides 2–I	V	V	IV–IV	III–0	0–0	0
F. trichothecioides 2–II	IV	III	III–III	III–III	0–0	0
F. trichothecioides 2–III	IV	III	II–III	0–0	0–0	0
F. trichothecioides 3–I	V–V	0–0	0–0	0–0	0–0	0
F. trichothecioides 3–II	V–V	III–II	0–II–0	0–0	0–0	0
F. trichothecioides 4–I	IV–IV	IV–III	III–0–III	I–0–II	0–0–0	0
F. trichothecioides 4–II	III–V	0–III–V	II–0–0	0–0	0–0	0
F. trichothecioides 5	IV–V–V	III–III–III	III–II	0–0	0–0	0
F. trichothecioides 6	V	IV	II–II	0–0	0–0	0
F. trichothecioides 7–I	V	V	IV–IV	0–IV–IV	0–0	0
F. trichothecioides 7–II	I–I–I–I	0–0–0–0	0–0	0–0	0–0	0
F. tricinctum 1–II	III–II	0	0–0	0–0	0–0	0
F. tricinctum 1–III	III–III	I	0–0	0–0	0–0	0
F. tricinctum 1–IV	III–IV	I	0–0	0–0	0–0	0
F. tricinctum 1–V	III–IV	I	0–0	0–0	0–0	0

TABLE 8.—(*Continued*)

Organism	0.0002%	0.0005%	0.001%	0.002%	0.004%	0.01%
F. tricinctum 1–VI	I–I–II–II	0–0–0	0–0	0–0	0–0	0
F. tricinctum 1–VII	IV–IV	I	0–0	0–0	0–0	0
F. tricinctum 1–VIII	II–II	I	0–0	0–0	0–0	0
F. tricinctum 1–IX	III–IV	I	0–0	0–0	0–0	0
F. tricinctum 2	III–III–III	II–III–III	0–0	0–0	0–0	0
F. uncinatum	III–III	I–I–I	0–I–0	0–0–0	0–0	0
F. urticearum I	IV–IV–III	III–III–III	0–II–0–0	0–0	0–0	0
F. urticearum II	IV–IV–III	III–III–III	0–0–0	0–0	0–0	0
F. vasinfectum	V	V	III–IV	0–0	0–0	0
F. viride 1	IV	IV	III–IV	III–III	0–0	0
F. viride 2	V	V	III–III	III–II	0–0	0
F. viticola	III–III–III	II–II–II	0–0	0–0	0–0	0
F. zonatum 1	V	V	III–III	0–0	0–0	0
F. zonatum 2	IV	II	II–0–0	I–0–0	0–0	0
F. zonatum 3	V	IV	IV–III	III–II	0–0	0

0
F. anguoides → 0.001 per cent malachite green =
III → agar → 0.001 per cent malachite green = V / IV / III

0 → nutrient solution = 0
F. asclerotium → 0.004 per cent malachite green = III
0

II
F. bullatum II → 0.001 per cent malachite green = 0
0 → nutrient solution = 0

F. camptoceras II → 0.004 per cent malachite green = II → agar → 0.004 per cent = 0 / 0 / 0

0
F. conglutinans → 0.004 per cent malachite green = 0 → nutrient solution = V → agar → 0.004 per cent malachite green =
III

II → agar → 0.004 per cent malachite green = 0 / 0 / 0
II
0 → nutrient solution = V → agar → 0.004 per cent malachite green = 0 / 0 / 0

II
F. cubense 1 → 0.004 per cent malachite green = 0
0 → nutrient solution = V → agar → 0.004 per cent malachite green = 0 / 0 / 0

IV
F. culmorum 3–I → 0.0005 per cent malachite green = 0 → nutrient solution = V → 0.0005 per cent malachite green = III
V
V
V → agar → 0.0005 per cent malachite green = V / V / V

V
F. culmorum 3–II → 0.0001 per cent malachite green = 0 → nutrient solution = 0
IV
IV

F. dimerum → 0.004 per cent malachite green = $\begin{matrix} \text{I} \\ \text{IV} \\ 0 \end{matrix}$ → nutrient solution = V → agar → 0.004 per cent malachite green = $\begin{matrix} \text{V} \\ \text{V} \\ \text{III} \end{matrix}$

F. fructigenum maius 2–VIII → 0.001 per cent malachite green = $\begin{matrix} 0 \\ 0 \end{matrix}$ → nutrient solution = III → agar → 0.001 per cent malachite green = $\begin{matrix} 0 \\ 0 \\ \text{I} \end{matrix}$

F. fructigenum maius 3–III → 0.0005 per cent malachite green = $\begin{matrix} \text{IV} \\ 0 \end{matrix}$ → nutrient solution = III → agar → 0.0005 per cent malachite green = $\begin{matrix} \text{V} \\ \text{V} \\ \text{III} \end{matrix}$

F. incarnatum IV → 0.001 per cent malachite green = $\begin{matrix} \text{II} \\ 0 \\ 0 \end{matrix}$ → nutrient solution = 0

F. incarnatum V → 0.001 per cent malachite green = $\begin{matrix} 0 \\ \text{II} \\ 0 \end{matrix}$ → nutrient solution = 0

F. martii 1 → 0.001 per cent malachite green = $\begin{matrix} \text{V} \\ \text{V} \\ 0 \end{matrix}$ → nutrient solution = IV → agar → 0.001 per cent malachite green = $\begin{matrix} 0 \\ 0 \\ 0 \end{matrix}$

F. martii 2 → 0.002 per cent malachite green = $\begin{matrix} \text{III} \\ 0 \\ \text{V} \end{matrix}$ → agar → 0.002 per cent malachite green = $\begin{matrix} \text{III} \\ \text{III} \\ \text{III} \end{matrix}$

F. martii phaseoli 1–I → 0.002 per cent malachite green = $\begin{matrix} 0 \\ \text{III} \\ 0 \end{matrix}$ → nutrient solution = II → agar → 0.002 per cent malachite green = $\begin{matrix} 0 \\ 0 \\ 0 \end{matrix}$

F. martii viride → 0.004 per cent malachite green = $\begin{matrix} 0 \\ \text{III} \\ 0 \end{matrix}$ → nutrient solution = 0

F. moniliforme minus → 0.004 per cent malachite green = $\begin{matrix} 0 \\ \text{III} \\ 0 \end{matrix}$ → nutrient solution = III → agar → 0.004 per cent malachite green = $\begin{matrix} 0 \\ 0 \\ 0 \end{matrix}$

F. orthoceras trisceptatum → 0.004 per cent malachite green = I 0 → nutrient solution = V → agar → 0.004 per cent malachite green = 0 0 0

F. oxysporum nicotianae → 0.002 per cent malachite green = 0 I III → agar → 0.002 per cent malachite green = III III

F. solani → 0.002 per cent malachite green = 0 V 0 → nutrient solution = V → agar → 0.002 per cent malachite green = V III

V → agar → 0.002 per cent malachite green = V V

F. solani minus 2–I → 0.004 per cent malachite green = III III 0 → nutrient solution = 0

F. solani 4–II → 0.002 per cent malachite green = II IV V → agar → 0.002 per cent malachite green = II II I

F. sambucinum 2 → 0.0005 per cent malachite green = III III 0 → nutrient solution = V → agar → 0.0005 per cent malachite green =

0 0 II → agar → 0.0005 per cent malachite green = 0 0 0

F. tricinctum IV → 0.001 per cent malachite green = 0 0 → nutrient solution = 0

F. trichothecioides 4–II → 0.001 per cent malachite green = II 0 → nutrient solution = 0

Growth in Presence of Mercurochrome and Tannin

Two concentrations of mercurochrome (.1 and 0.2 per cent) and two concentrations of tannin (0.25 and 0.5 per cent) were used in these experiments. In order to eliminate precipitation, the nutrient solution for the mercurochrome tests was modified by replacing dihydrogen potassium phosphate with the same quantity of sodium nucleinate and by adding the dye after the solution was sterilized. Plugged, sterilized test-tubes were then filled by means of sterile 2 c.c. pipettes.

Readings were made two weeks after the transfer of the inoculum and the results are shown in the following table:

It can be seen that most of the organisms can tolerate comparatively large amounts of mercurochrome and tannic acid. Nevertheless, the same lack of uniformity of individual reactions, the same dissimilarity of different strains of a given species in their reactions towards a given environmental factor are to be witnessed here. *F. culmorum* 4–II and 6–I can grow in the presence of 0.2 per cent mercurochrome, while the remaining strains can not, just as nos. 3–I, 4–I and 6–I tolerate 0.5 per cent tannic acid whereas all others do not. *F. fructigenum maius* 3–I and 3–II are the only ones of the eleven strains of this species that can not tolerate 0.5 per cent tannic acid, and *F. fructigenum maius* 3–II can not tolerate even 0.25 per cent tannic acid. *F. incarnatum* II and V can not grow in the presence of 0.1 per cent mercurochrome, while nos. I and IV can. *F. martii phaseoli* 1–I, 1–III and 2–II show no sign of growth when there is 0.25 per cent tannic acid in the nutrient solution, while all other strains of *F. martii* and its varieties grow very well in such a solution. *F. moniliforme* 3 again shows a sharp departure from the other 8 strains by failing to grow in the presence of tannic acid. Such constant departures indicate that this strain may be an entirely different species. *F. niveum* 1 grows in the presence of 0.5 per cent tannic acid, while no. 2 does not. *F. ossicolum* 1, unlike no. 2, does not tolerate either mercurochrome or tannic acid. The strains of *F. semitectum* are extremely dissimilar in their reactions. *F. semitectum* 1–VIII, 1–X, 1–XVII, and 1–XVIII are the only ones capable of growing in the presence of 0.5 per cent tannic acid, while 1–II, 1–V, 1–VI, 1–VII, 1–IX, 1–XI, 1–XII, 1–XIV, 1–XV, 1–XVI and *F. semitectum* 2 can not tolerate even 0.25 per cent of the acid. *F. solani* 2–I is the only member of the solani group capable of growing very readily in the presence of 0.5 per cent tannic acid, while all others either do not grow at all, or grow very slightly or occasionally. Similarly, *F. striatum* 2 gives positive results in 0.5 per cent tannic acid while no. 1–II gives negative results. Certain members of the *F. trichothecioides* group exhibit a similar departure from the common path. On the other hand, the strains of *F. tricinctum* are remarkably uniform in

TABLE 9.—*Growth in presence of mercurochrome and tannic acid (2 weeks at 25° C.)*

Organism	Mercurochrome		Tannic acid	
	0.1%	0.2%	0.25%	0.5%
F. acuminatum 1	II–II	I–I–I	III–II	0–0
F. acuminatum 2–I	II–II	0–0–0	I–III	0–0
F. acuminatum 2–II	II–II	0–0–0	II–III–II	0–0–0
F. acuminatum 2–III	II–II	0–II–0–0	II–III–II	0–0–0
F. acuminatum 2–IV	II–II	0–I–0–I	II–III–IV	0–0–0
F. acuminatum 2–V	III–I	0–0–0	0–II–II	0–0–0
F. acuminatum 2–VI	I–I–I	0–0–0	I–II–II	0–0–0
F. acuminatum 2–VII	I–I	0–0–0	II–I–II	0–I–0–0
F. acuminatum 2–VIII	I–I	0–0–0	0–II–IV–III	0–0–0
F. alluviale	II–II	0–0–0	III–III	0–0
F. anthophilum	0–0–0	0–0	II–II	0–0
F. aquaeductuum pusilum	0–0	0–0	0–0	0–0
F. aquaeductuum volutum	0–0	0–0–0	0–0–0	0–0–0
F. arcuatum	0–II–0–0	0–I–0–0	III–II	0–0–0
F. asclerotium	III–III	I–II–II	V–V	IV–V
F. aurantiacum	III–II	I–II–II	IV–IV	IV–IV
F. batatatis 1	II–II	0–0	III–IV	I–I
F. batatatis 2	III–III	0–I–II–II	IV–IV	III–III
F. bulbigenum	III–III	II–II–II	IV–IV	IV–III
F. bullatum I	I–0–I–0	0–0–0	III–II–III	0–I–II
F. bullatum II	II–I–0–I	0–0–0	III–III–III	I–II–II–I
F. bullatum brevius	I–0–0–0–0	0–0	III–III	II–I
F. camptoceras I	I–I–I	0–I–I–I–I	III–III–III	III–II–I
F. camptoceras II	II–II	0–I–0–0	IV–IV–III	III–II–0–0
F. caudatum	0–I–0–0	0–I–0–0–0–I	0–0	0–0
F. chlamydosporum I	II–I–0	0–0–0	0–0–0	0–0–0
F. chlamydosporum II	II–II–I	0–I–0–0	0–0–0	0–0–0
F. chlamydosporum III	I–I–0–0	0–0–0	0–0–0	0–0–0
F. chenopodinum	I–II–0	0–0	0–0	0–0
F. coeruleum 1–I	II–III–II	0–I–I	II–IV–II	0–0–0–0
F. coeruleum 1–II	I–III	0–0–I–I	0–0–IV–0	0–0–0
F. coeruleum 2	II–II	0–I–0–I	II–IV	I–0
F. coeruleum 3	I–0–0	0–0	II–0	0–0

TABLE 9.—(*Continued*)

Organism	Mercurochrome		Tannic acid	
	0.1%	0.2%	0.25%	0.5%
F. commutatum	I–I–I	0–0	0–0	0–0
F. conglutinans	II–I	0–II–0–0–0	III–IV	II–IV
F. cubense 1	II–II	0–0	IV–IV	IV–IV
F. cubense 2	II–I	0–0	IV–IV	III–III
F. culmorum 1–I	0–I–I–II	0–0–0	0–0–0	0–0–0
F. culmorum 1–II	0–I–I	0–0–0	0–0–0	0–0–0
F. culmorum 2	II–II	0–0	0–0	0–0
F. culmorum 3–I	III–III	0–0–0	III–III–IV	0–III–III–I
F. culmorum 3–II	II–I	0–0–0	II–II–II	0–0–0
F. culmorum 4–I	II–II	0–0–I	III–III–III	I–0–II–I–0
F. culmorum 4–II	III–III	0–I–II–II	III–II–II	0–0–0
F. culmorum 5	III–III	0–I–0–0	0–III–III–II	0–0–0–0
F. culmorum 6–I	III–III	III–II–II	IV–IV–IV	III–IV–IV
F. culmorum 6–II	II–II–II	0–0–0	0–0–0	0–0–0
F. decemcellulare	I–I–I	0–0–0	II–II–II	0–0–0
F. dimerum	I–I	0–0	0–0	0–0
F. ensiforme	II–0–0	0–0	0–0	0–0
F. eumartii 1–I	IV–III	I–II–II	0–0–0	0–0–0
F. eumartii 1–II	IV–III	II–II–II	0–0–III–II	0–0–0
F. eumartii 2–I	I–II–II	I–I–I	0–0–0	0–0–0
F. eumartii 2–II	I–III–II	0–I–0	0–0	0–0–0
F. eumartii 3	II–II	I–I	0–0	0–0
F. euoxysporum	III–III	II–0–I–II	III–IV	0–II–II–I
F. falcatum	0–0	0–0	0–0	0–0
F. filiferum I	II–I–I–0	0–I–0–II	II–IV–II	0–0–I
F. filiferum II	II–II–I	0–I–I	III–III–IV	I–0–0–I
F. flocciferum	0–0	0–0	0–0	0–0
F. fructigenum	I–0–0	0–0	III–III	0–0
F. fructigenum maius 1	II–0	0–0	IV–IV	II–II
F. fructigenum maius 2–I	II–0–0	0–0	IV–IV	II–III
F. fructigenum maius 2–II	0–I	0–0	IV–IV	III–III
F. fructigenum maius 2–III	I–I	0–I–0–0	IV–IV–III	0–I–III–0–I
F. fructigenum maius 2–IV	II–II	0–0–0	IV–IV–IV	III–IV–III

TABLE 9.—(*Continued*)

Organism	Mercurochrome		Tannic acid	
	0.1%	0.2%	0.25%	0.5%
F. fructigenum maius 2–V	I–I	0–0–0	III–III–III	III–II–II
F. fructigenum maius 2–VII	I–I	0–0–I	III–III–III	0–I–II–0
F. fructigenum maius 2–VIII	I–I	0–I–0	III–IV–IV	0–III–0
F. fructigenum maius 3–I	I–I	0–I–0–0	0–III–II–0	0–0–0
F. fructigenum maius 3–II	I–0	0–0	0–0	0–0
F. fructigenum maius 3–III	I–II–I	0–0–0	II–III–III–IV	0–I–0–0–I
F. gibbosum	II–0–0	0–I–0–0	II–III	0–0
F. graminum 1	I–0–I	0–0	II–III	0–0
F. graminum 2–I	0–0	0–0	IV–IV	0–I–0
F. graminum 2–II	II–0–0	I–0–0	III–IV–IV	III–III
F. herbarum 1	0–I–0–II	0–0	IV–II	III–0
F. herbarum 2	I–I–0–0	0–0	II–II	0–0
F. herbarum gibberalloides I	III–III	0–0–0	II–III–III	0–I–I–0
F. herbarum gibberalloides II	II–II	0–I–0–0–0	III–III–III	0–0
F. herbarum pirinum I	I–II–II	I–I–I	0–I–II–III	0–0–0
F. herbarum pirinum II	II–II–II	I–I–I	I–0–I–III–0	0–0–0
F. hyperoxysporum 1	III–III	II–0	IV–IV	III–II
F. hyperoxysporum 2	III–III	II–II	IV–IV	IV–III
F. incarnatum I	I–II–I	0–II–I–0	III–III–IV	III–I–II
F. incarnatum II	0–0	0–0–0	II–III	I–I
F. incarnatum IV	III–III–I	0–0–0	III–III–III	II–I–II
F. incarnatum V	0–0	0–0–0	II–II–II	0–I–0–0
F. javanicum 1	II–II	0–0	IV–IV	II–II
F. javanicum 2	II–II	I–I	IV–IV	IV–IV
F. lateritium I	I–0	0–0	I–II	0–0
F. lateritium II	I–0–I	0–0–0	0–II–II–I	0–0–0
F. lini	I–III–III	I–0–0–0–II	II–III	0–0–0
F. lolii	II–II	0–I–0	III–I	III–I
F. loncheceras	III–IV	II–0–III–III	IV–IV	IV–IV
F. loncherceras microsporum	III–II	II–I–0–I	III–IV	III–III
F. longipes	0–I–I–0	0–0	II–II	0–0

TABLE 9.—(*Continued*)

Organism	Mercurochrome		Tannic acid	
	0.1%	0.2%	0.25%	0.5%
F. lutulatum I	III–III	0–I–II–I–II	IV–IV–IV	III–III–III
F. lutulatum II	III–II	0–II–II–II	IV–IV–IV	III–IV–III
F. lycopersici 1	II–I	I–0–0–I	IV–IV	III–III
F. lycopersici 2	III–III	I–I–I	IV–IV	III–IV
F. malli	III–III	II–II	IV–IV	IV–IV
F. macroceras	II–II	0–I–I	0–I	0–0
F. martii 1	III–III	I–II–II	IV–IV	0–III–0
F. martii 2	III–III	II–II	IV–IV	III–III
F. martii 3–I	III–IV–III	0–II–I	IV–II–III	0–I–0–0
F. martii 3–II	III–IV–III	IV–I–III–II–II	II–IV–III	0–0–0
F. martii minus	III–III	II–0–III	III–IV	0–II–0
F. martii phaseoli 1–I	III–III	III–III–I	0–0–0	0–0–0
F. martii phaseoli 1–II	III–III–II–III	I–III–I–I	II–III–III	0–II–I–0
F. martii phaseoli 1–III	IV–IV	II–II	0–0–0–0	0–0–0–0
F. martii phaseoli 2–I	I–I–II	I–0–0–I	II–IV–0	0–0–0–0
F. martii phaseoli 2–II	II–IV–I	I–III–0	0–0–0	0–0–0–0
F. martii pisi	III–III	II–0	IV–IV	III–III
F. martii viride	III–III	0–II–I	IV–IV	I–III
F. moniliforme 1	II–I	0–0	III-III	III–II
F. moniliforme 2	III–III	II–I–II	III–IV	III–IV
F. moniliforme 3	II–II	0–I–I–0	0–0	0–0
F. moniliforme 4	III–II	0–I–I	III–IV	III–III
F. moniliforme 5	II–III	I–II	IV–IV	III–III
F. moniliforme erumpens I	II–III	0–I–I–I	IV–IV–IV	III–III–III
F. moniliforme erumpens II	II–III	I–I–I	IV–IV–V	III–III–IV
F. moniliforme minus	III–III	I–II	III–IV	III–III
F. moniliforme subglutinans	I–I	0–0–0	IV–IV	III–III
F. neoceras	III–I	0–I–I	IV–IV	III–III
F. niveum 1	III–II	I–I–I	IV–IV	III–III
F. niveum 2	II–I	0–0	IV–IV	0–0
F. orthoceras	III–II	0–I–II–I	IV–IV	III–III
F. orthoceras triseptatum	III–III	I–II–II	IV–IV	IV–IV
F. ossicolum 1	0–0	0–0–0	0–0–0	0–0–0

TABLE 9.—(*Continued*)

Organism	Mercurochrome		Tannic Acid	
	0.1%	0.2%	0.25%	0.5%
F. ossicolum 2	II–I	0–I–II	I–IV	0–III–II
F. oxysporum 1	III–II	II–II–II	IV–IV	III–IV
F. oxysporum 2	II–III	0–I–II	V–IV	V–IV
F. oxysporum nicotianae	III–III	II–II–II	IV–V	III–IV
F. paspalicola	III–II	I–0–I–I	II–III	0–0
F. pirinum	I–0–0	0–0	III–II	0–0
F. poae I	0–0–0–0	0–0–0	III–III–III	0–I–0–0
F. poae II	I–0–0–0	0–0–0	III–III–IV	0–I–I–0
F. polymorphum	0–0	0–0	0–0	0–0
F. pusillum	III–III	I–II–0–II	III–IV	0–0
F. radicicola	II–III	0–I–II–I	III–IV	I–II
F. rhizochromatistes	III–III	III–III	IV–IV	III–III
F. rhizochromatistes-microsclerotium	III–III	I–0–II	IV–IV	IV–IV
F. sambucinum 1	I–0–0	0–0	0–0	0–0
F. sambucinum 2	I–II–II	0–I–I	I–II	I–I
F. scirpi	III–II	I–I–I	II–0	0–0
F. sclerostromaton	II–II	I–0–I–II	IV–IV	IV–IV
F. semitectum 1–I	I–II	I–I–I	0–III–II–II	0–0–0
F. semitectum 1–II	I–I	0–I–0–I	0–0–0	0–0–0
F. semitectum 1–III	I–III	0–I–II–I	0–II–0–II	0–0–0
F. semitectum 1–IV	II–II	0–I–I–0	0–0–II–III	0–0–0
F. semitectum 1–V	I–0–0	0–0–0	0–0–0	0–0–0
F. semitectum 1–VI	I–0–0	0–I–0–0	0–0–0	0–0–0
F. semitectum 1–VII	I–I	0–I–0–0	0–0–0	0–0–0
F. semitectum 1–VIII	III–III	II–III–II	IV–IV–V	III–IV–V
F. semitectum 1–IX	II–I	0–I–I–0	0–0–0	0–0–0
F. semitectum 1–X	II–I	0–0–0	II–III–III	I–I–II
F. semitectum 1–XI	I–II	0–I–I–0	0–0–0	0–0–0
F. semitectum 1–XII	I–I	0–I–I–I	0–0–0	0–0–0
F. semitectum 1–XIII	I–0–0	0–I–0–0	0–III–0–0–0	0–I–0–0–0
F. semitectum 1–XIV	I–0–0	0–0–0	0–0–0	0–0–0
F. semitectum 1–XV	II–0–0	0–I–0–0	0–0–0	0–0–0

TABLE 9.—(*Continued*)

Organism	Mercurochrome		Tannic Acid	
	0.1%	0.2%	0.25%	0.5%
F. semitectum 1–XVI	II–I	I–I–0–0	0–0–0	0–0–0
F. semitectum 1–XVII	II–I	0–0–0	III–IV–III	I–II–I
F. semitectum 1–XVIII	I–0–I	0–0–0	III–0–I	II–0–0
F. semitectum 2	II–II	II–I	0–0–0	0–0–0
F. solani 1	III–II	0–I–I	IV–IV	0–III–0
F. solani 2–I	III–IV–IV	IV–III–IV	IV–IV–IV	III–IV–IV
F. solani 2–II	IV–V	II–II	II–IV	0–0
F. solani 3–I	III–III	I–III–I	IV–IV–III	0–I–I
F. solani 3–II	III–III	I–III–I	IV–0–IV–0	0–0–0
F. solani 3–III	IV–III	I–III–I	IV–IV–IV	0–I–0–I
F. solani 4–I	II–III	0–I–I	0–IV–IV–0	0–0–0
F. solani 4–II	III–IV	0–I–III	0–IV–V	0–0–0
F. solani minus 1–I	IV–III	0–II–I–II	III–0–IV–0	0–0–0
F. solani minus 1–II	IV–III	0–I–I–I	II–0–0	0–0
F. solani minus 2–I	III–III	I–II–II	IV–V–IV	I–0–I–II
F. solani minus 2–II	III–II	0–II–I–I	III–IV–III	0–0–0
F. solani suffuscum	II–I	0–0	II–III	0–0
F. spinaceae 1	III–II	0–II–II	IV–III	II–I
F. spinaceae 2	III–III	I–I	III–IV	II–II
F. striatum 1–I	III–III	0–II–I–II	IV–IV–V	I–I–I
F. striatum 1–II	I–I	0–0–0	I–III–III	0–0–0
F. striatum 2	I–II	0–II–0	IV–IV	III–III
F. striatum 3–I	II–III	0–I–II–I	0–0–IV–II	0–0–I–0
F. striatum 3–II	III–III	0–II–II–II	III–IV–III	0–0–0
F. sulphureum 1	I–I–I	0–0	II–II	0–I–0
F. sulphureum 2	I–II–I	0–0	0–0	0–0
F. sulphureum 3	I–II–I	0–I–I	II–II	0–0
F. theobrome	II–III	0–I–I–0	III–IV	0–0
F. tracheiphilum	III–III	0–II–II	IV–IV	III–III
F. trichothecioides 1	0–0	0–0	IV–V	IV–V
F. trichothecioides 2–I	I–II–I	0–I–0–0	0–IV–IV	0–0–0
F. trichothecioides 2–II	II–III–I	0–I–I–I	III–III–III	0–I–II
F. trichothecioides 2–III	I–I–I	0–0–0	0–II–I	0–0–0
F. trichothecioides 3–I	0–I–0–0	0–0–0	II–III–IV	II–II–II

TABLE 9.—(*Continued*)

Organism	Mercurochrome		Tannic Acid	
	0.1%	0.2%	0.25%	0.5%
F. trichothecioides 3–II	0–0–0	0–0–0	III–III–IV	0–0–0
F. trichothecioides 4–I	0–0–II–0	0–0–0–0	0–0–0	0–0–0
F. trichothecioides 4–II	I–I–I	0–0–0	II–III–III	0–I–I–0
F. trichothecioides 5	III–II	0–I–I–0	III–IV	II–III
F. trichothecioides 6	III–I–III	0–I–I–II	IV–V	III–IV
F. trichothecioides 7–I	II–II	I–I–I	0–0–IV–0	0–0–0
F. trichothecioides 7–II	0–0	0–0–0	III–III–III	II–I–0
F. tricinctum 1–II	0–0	0–0–0	I–0–II–0	0–0–0
F. tricinctum 1–III	0–0	0–0–0	0–I–II–II	0–I–0–0
F. tricinctum 1–IV	0–0	0–0	0–I–0–III	0–0–0–0
F. tricinctum 1–V	0–0	0–0–0	II–II–I	0–0–0
F. tricinctum 1–VI	0–0	0–0–0	II–II–II	0–0–0
F. tricinctum 1–VII	0–0	0–0–0	0–II–0–0	0–0–0
F. tricinctum 1–VIII	0–0	0–0–0	0–II–0–0	0–0–0
F. tricinctum 1–IX	0–0	0–0–0	I–I–II	0–0–0
F. tricinctum 2	0–0	0–0	II–II	II–I
F. uncinatum	II–II–II	I–II–II	III–III–IV	II–III–II
F. urticearum I	I–I	0–0–0	0–0–0	0–0–0
F. urticearum II	I–I	0–0–0	0–0–0	0–0–0
F. vasinfectum	II–III	0–III–II	IV–IV	IV–IV
F. viride 1	III–III	I–I–I	III–IV	II–II
F. viride 2	III–II	II–II	V–V	IV–V
F. viticola	II–I–I	0–0	II–III	II–0
F. zonatum 1	III–II	0–0–0	IV–V	II–II
F. zonatum 2	III–II	II–II	IV–III	III–III
F. zonatum 3	III–III	I–II–II	IV–IV	IV–IV

F. camptoceras II → 0.5 per cent tannin = III / II / 0 → 0 → nutrient solution = V → agar → 0.5 per cent tannin = 0 / 0 / 0

F. eumartii 2–II → 0.5 per cent tannin = 0 / 0 → nutrient solution = 0

F. herbarum pirinum II → 0.25 per cent tannin = I / 0 / III → 0 → nutrient solution = 0

F. lini 1 → 0.5 per cent tannin = 0 / 0 → 0 → nutrient solution = 0

F. martii minus → 0.5 per cent tannin = 0 / II → 0 → nutrient solution = 0

F. semitectum 1–XIII → 0.25 per cent tannin = 0 / 0 → 0 → nutrient solution = 0

F. solani → 0.5 per cent tannin = III / 0 → 0 → nutrient solution = 0

F. solani minus 1–I → 0.25 per cent tannin = III / 0 / IV → 0 → nutrient solution → V → agar → 0.25 per cent tannin = V / V / III

F. solani minus 1–II → 0.25 per cent tannin = II / 0 → 0 → nutrient solution = V → agar → 0.25 per cent tannin = V / V / V

F. tricinctum 1–IV → 0.25 per cent tannin = 0 / I / 0 → III → agar → 0.25 per cent tannin = III / II / II

their reactions towards mercurochrome and 0.5 per cent tannic acid. Other groups are also capable of exhibiting such a behavior as an examination of the foregoing table will show.

In case of a few organisms the effect of tannic acid was tested for two successive generations and it was found that tannin can act not only as an inhibitive substance, but, as the following results indicate, it seems to be toxic enough to kill some of the organisms.

GROWTH IN PRESENCE OF VARIOUS AMOUNTS OF SODIUM TRIBROMPHENATE AND SODIUM 2.4–DINITROPHENOXIDE

In their search for a suitable internal antiseptic, Bechhold and Ehrlich (1) found that the introduction of halogens into the phenol ring increased the disinfecting property of phenol to such an extent that one molecule of pentabromphenol exhibited the same action on the diphtheria bacillus as 500 molecules of phenol. An interesting fact brought to light by these two investigators was that the introduction of halogens into phenol in such proportion as to form monobromphenol, actually lowers the toxicity; but the toxic property is increased in tribromphenol, reaching its peak with tetra- and pentabromphenols, to be lowered and lost again with the higher halogen-bound substances. Archer[12] found that the sodium salt of tribromphenol gave very satisfactory results when used as a disinfectant against five species of bacteria.

A preliminary test with sodium tribromphenate gave such satisfactory results that the writer used it to obtain differential growth in Fusaria. Large numbers of phenol compounds have been tested and discarded because they lacked the ability to exert marked inhibitive action even in comparatively high concentrations. Sodium tribromphenate and sodium 2.4-dinitrophenoxide yielded the best results. Three concentrations of sodium tribromphenate (0.001, 0.0025, and 0.005 per cent) and two concentrations of sodium dinitrophenoxide (0.01 and 0.02 per cent) have been used. The sodium salt of tetrachlor-phenol is much more powerful than sodium tribromphenate, but owing to a delay in securing this compound, the writer has not had the opportunity to test all of his cultures and incorporate the results in this paper.

Twenty strains failed to grow in the presence of 0.001 per cent sodium tribromphenate, and fifteen others made only a slight growth. Less than one-third of all the Fusaria used were able to make any sort of growth when the amount of this substance was increased to 0.005 per cent. In case of sodium dinitrophenoxide, however, comparatively few strains were totally inhibited.

[12] Archer, W. A. The comparative values of the disinfecting action of sodium tribromphenate and other chemicals. (Unpublished.)

TABLE 10.—*Growth in presence of sodium tribromphenate and sodium dinitrophenoxide (2 weeks at 25° C.)*

Organism	Tribromphenol sodium salt			Sodium 2.4 dinitrophenoxide	
	0.001%	0.0025%	0.005%	0.01%	0.02%
F. acuminatum 1		II–II	0–0–0–0	III–III–III–III	II–0–0–0
F. acuminatum 2–I	III–III–0–0–0	0–0	0–0–0	0–IV–II–0	0–0–0–0
F. acuminatum 2–II	III–IV	0–0	0–0–0	0–0–0–0	0–0–0–0
F. acuminatum 2–III	III–III	0–0	0–0–0	IV–0–0–III	0–0–0–0
F. acuminatum 2–IV	II–I	0–0	0–0–0	V–V–V–0	0–0–0–0–IV
F. acuminatum 2–V	0–0–0–0	0–0–0	0–0–0	0–II–0–III	0–0–0–0
F. acuminatum 2–VI	0–II–0–0–III	0–0	0–0–0	III–0–0–0	0–0–0–0
F. acuminatum 2–VII	II–I	0–0	0–0–0	0–0–0	0–0–0–0
F. acuminatum 2–VIII	0–0	0–0	0–0–0	0–0–0	0–0–0–0
F. alluviale		II–IV	0–0–0	V–V–V–V	V–V–V–V
F. anthophilum	III–III	0–0	0–0–0	0–II–II–I	I–0–0–0
F. aquaeductuum pusillum	IV–V	0–0	I–0	II–0–0	0–0–0–0
F. aquaeductuum volutum	0–0–0	0–0	0–0–0	I–0–0–0	0–0–0–0
F. arcuatum	II–III	0–0	0–0–0	0–0–II	0–0–0–0
F. asclerotium		IV–IV	II–0–I–I	V–IV–V	V–III–I–IV
F. aurantiacum		IV–IV	II–II–II	IV–V–I–V	V–II–0–IV
F. batatatis 1		II–II	0–0–I–I	V–V–V	II–I–V–II
F. batatatis 2		IV–V	I–I–I–I	IV–V–V–V	II–0–0–I
F. bulbigenum	III–IV	I–I–II	0–0–I–0	V–V–II–V	V–0–III–IV
F. bullatum I	IV–IV	II–I	0–0–0	0–V–V–II	0–II–0–0
F. bullatum II	V–V	II–I	0–0–0	V–III–IV–V	0–0–0–0
F. bullatum brevius		III–III	0–0–0–II	V–V–V–V	V–V–III–0–0
F. camptoceras I		III–III	0–0–I–0–0	IV–IV–IV	0–0–III–IV–III
F. camptoceras II		II–I	0–0–0–0	III–IV–0–III	0–0–IV–III–0
F. caudatum		I–0–0–0	0–0–0–0	0–0–0–II	0–0–0–0
F. chlamydosporum I	I–II	0–0–0	0–0–0	0–0–0–II	0–0–0–0
F. chlamydosporum II	II–II	0–0	0–0–0	III–III–II–II	II–0–0–II
F. chlamydosporum III	III–V	0–0	0–0–0	II–0–II–0	0–0–0–I
F. chenopodinum	II–II	0–0–0	0–0–0–0	0–0–0–III	0–0–0–III
F. coeruleum 1–I		V–V	II–II–II–IV	V–V–V–V	V–V–V–V
F. coeruleum 1–II		II–IV	0–0–0–0	V–V–V–V	V–II–I–V
F. coeruleum 2		V–V	0–0–0–0	V–V–V–V	V–V–II–IV
F. coeruleum 3	I–I	0–0	0–0–0	0–0–0–0	0–0–0–0
F. commutatum	I–I–0–0	0–0	0–0–0–0	II–I–II–0	0–0–0–I

TABLE 10.—(*Continued*)

Organism	Tribromphenol sodium salt			Sodium 2.4 dinitrophenoxide	
	0.001%	0.0025%	0.005%	0.01%	0.02%
F. conglutinans		V–V	I–II–V–IV	V–V–V–V	II–II–III–III
F. cubense 1		III–III	I–0–I–II	V–V–V–V	V–V–IV–IV
F. cubense 2		III–III	0–0–0–0	V–V–II–V	0–I–II–V
F. culmorum 1–I	II–III	0–0	0–0–0	V–II–V–0	0–0–0–0
F. culmorum 1–II	II–III	0–0	0–0–0	0–0–V	0–0–0–0
F. culmorum 2	III–IV	0–0	0–0–0	III–0–0–II	0–0–0–0
F. culmorum 3–I	III–IV	II–II–0	0–0–0–0	0–V–III–III	I–0–0–III
F. culmorum 3–II	0–0–0–0	0–0–0	0–0–0	III–0–0–0	0–0–0–0
F. culmorum 4–I		I–III	0–0–0–0	IV–III–III–0	0–0–0–0
F. culmorum 4–II		III–III	0–0–0–0	IV–IV–III–V	0–0–III–II
F. culmorum 5	I–I	0–0	0–0–0	0–V–II–0	0–0–0–0
F. culmorum 6–I		V–V	0–0–II–II	III–V–V–V	0–0–II–V
F. culmorum 6–II	III–III	0–II–0	0–0–0–0	IV–V–I–V	0–0–0–I
F. decemcellulare		II–III	0–0–0–0	V–0–V–V–V	I–0–0–I
F. dimerum	0–0	0–0	0–0–0	III–0–0–II	I–0–0–II
F. diversisporum	II–I	0–0	0–0–0–0	V–V–III–0	I–0–0–II
F. ensiforme	0–0–I–I	0–0	0–0–0	II–II–II	I–I–0–0
F. eumartii 1–I	0–0	0–0	0–I–0–0	V–IV–V–V	II–II–II–II
F. eumartii 1–II		IV–IV	I–0–0–I	V–V–V–V	V–II–I–IV
F. eumartii 2–I	V–V	IV–0	0–0	III–V–V	0–0–II–V
F. eumartii 2–II	I–I	0–0	0–0–0	0–0–V–V	II–I–III–II
F. eumartii 3	I–I	0–0	0–0–0	0–III–V–0	0–0–0–0
F. euoxysporum		III–IV	0–0–0–0	V–V–V	0–0–II–0
F. falcatum	I–0	0–0	0–0–0	II–0–0–II	0–0–0–0
F. filiferum I	IV–IV	0–V	0–0–0–0	IV–III–V	0–0–0–0
F. filiferum II	IV–IV	I–III	0–0–0–0	IV–IV–III	0–0–I–0
F. flocciferum	V–V	0–0	0–0–0	0–0–II–0	V–V–I
F. fructigenum	II–III	0–0	0–0–0–0	0–0–0	0–0–0
F. fructigenum maius 1	V–V	0–0	0–0–0	III–V–V	IV–IV–V
F. fructigenum maius 2–I	V–V	I–I	II–0–0–II	III–IV–0–V	0–0–III–V
F. fructigenum maius 2–II	IV–IV	II–II	0–0–0	II–V–V	IV–V–0–V
F. fructigenum maius 2–III	II–III	0–0	0–0–0	V–V–V	V–III–III–III
F. fructigenum maius 2–IV	IV–IV	I–II	0–0–0–0	V–IV–V	IV–V–0–V
F. fructigenum maius 2–V	III–IV	I–I	0–0–0	III–III–III	0–0–III–0

TABLE 10.—(*Continued*)

Organism	Tribromphenol sodium salt			Sodium 2.4 dinitrophenoxide	
	0.001%	0.0025%	0.005%	0.01%	0.02%
F. fructigenum maius 2–VII	IV–II	0–0	0–0–0–0	V–V–V	II–0–0–III
F. fructigenum maius 2–VIII	III–IV	I–II	0–0–0–0	V–III–V–III	III–0–0–III
F. fructigenum maius 3–I	II–0–I–II	0–0	0–0–0	V–IV–IV–0	0–0–0–0
F. fructigenum maius 3–II	III–0–I–II	0–0	0–0–0	0–0–0–0	0–0–0–0
F. fructigenum maius 3–III	IV–V–III–III	0–0	0–0–0	0–0–V–0	0–0–0–0
F. graminum 1	V–V	0–0	0–0–0–0	0–0–V–0	0–0–0–0
F. graminum 2–I	IV–IV	0–0	0–0–0	III–III–V–III	0–0–V–V
F. graminum 2–II	III–II	0–0	0–0–0	0–V–0–0	0–0–IV
F. gibbosum	IV–V	0–0	0–0–0–0	0–0–V–0	III–III–0–III
F. herbarum 1	II–III	0–0	0–0–0–0	0–0–0–0	0–0–0–0
F. herbarum 2	V–V	0–0	0–0–0–0	V–V–II–V	I–0–0–I
F. herbarum gibberalloides I	III–IV	I–I	0–0–0	II–II–II–II	II–0–0–I
F. herbarum gibberalloides II		II–III–IV	0–0–0	III–II–V–III	0–0–II–III
F. herbarum pirinum I	III–IV	0–0–0	0–0–0	IV–III–III–V	V–0–0–0–0
F. hebarum pirinum II	II–II	I–0–0	0–0–0–0	II–0–II–0	0–0–0–I–0
F. hyperoxysporum 1		V–V	II–IV–V–I	V–V–V	0–0–II–V
F. hyperoxysporum 2		IV–V	I–I–III–I	III–IV–V	I–II–V–IV
F. incarnatum I	III–V	I–I	0–0–0–0	IV–V–IV–V	III–I–0–II
F. incarnatum II	I–I	0–0	0–0–0–0	II–V–0–III	II–0–0–I
F. incarnatum IV	I–II	0–0	0–0–0–0	II–I–0–V	0–I–0–0
F. incarnatum V	0–0–0–0	0–0	0–0–0–0	III–III–I–II	II–0–0–I
F. javanicum 1		II–II	II–0–0–I	IV–V–V–V	I–I–0–III–V
F. javanicum 2		V–IV	II–II–0	III–V–V–V	0–0–0–III–III
F. lateritium I	I–II	I–I	0–0–0–0	II–III–II–II	0–0–0–0
F. lateritium II	II–II	0–I–0	0–0–0–0	III–III–0–III	0–0–0–0
F. lini		V–V	II–I–III	IV–IV	V–I–V–V
F. lolii	V–V	0–0	0–0–0–0	I–I–III–0	0–0–0–0
F. loncheceras		V–V	II–0–I–II	V–V–V–V	0–III–0–V
F. loncheceras microsporum	IV–IV	0–0	0–0–0	0–V–V–V	II–I–0–0
F. longipes	0–0	0–0	0–0–0	0–II–II–0	0–0–0–0
F. lutulatum I		III–III	II–I–II–II	IV–I–IV–III	IV–IV–IV–IV
F. lutulatum II		III–III	II–I–II–III	IV–II–V–V	IV–IV–III–III
F. lycopersici 1		II–II	0–0–I–0	V–V–V–IV	V–0–0–0–0
F. lycopersici 2		III–III	I–I–II–II	V–V–V–V	II–0–0–0–0

TABLE 10.—(*Continued*)

Organism	Tribromphenol sodium salt			Sodium 2.4 dinitrophenoxide	
	0.001%	0.0025%	0.005%	0.01%	0.02%
F. malli		V–V	0–0–II–0	V–V–IV–IV	0–0–IV–V
F. macroceras	III–III	I–I	0–0–0–0	III–II–II–III	0–0–0–0
F. martii 1		V–V	V–0–II–II	V–V–III	V–V–I–V
F. martii 2		IV–IV	II–II–II–II	V–V–V–V	I–V–IV–IV
F. martii 3–I		II–III	I–I–I–I	V–V–V–V	V–V–0–II
F. martii 3–II		II–IV	I–I–I–I	V–II–V–V	V–V–II–III
F. martii minus		IV–II	I–I–I–I	V–V–V–V	III–II–IV–V
F. martii phaseoli 1–I	I–IV	I–0–II–I	0–0–0–0	IV–V–V–III	0–0–II–II
F. martii phaseoli 1–II	V–V	0–0–0–0	0–I–I–I	IV–III–II–V	I–II–II–I
F. martii phaseoli 1–III	I–0–0–0	0–0–0	0–0–0	0–II–0–IV	V–V–II–I
F. martii phaseoli 2–I	V–V	0–0	0–0–0–0	III–IV–IV	0–0–I–IV
F. martii phaseoli 2–II	0–0–0–0	0–0	0–0–0–0	0–II–0–IV	0–V–0–0
F. martii pisi		III–III	I–I–II–I	III–V–V–III	II–0–IV–0
F. martii viride		V–V	II–II–I–II	V–V–V–V	V–V–V–V
F. moniliforme 1		III–III	0–0–I–I	V–V–V–V	III–I–0–0
F. moniliforme 2		IV–V	II–I–I–II	V–V–III–V	0–0–0–I
F. moniliforme 3		I–III	0–0–0–0	II–II–III–II	II–0–II–0–III
F. moniliforme 4		III–III	II–0–I–0	V–V–V–V	II–I–0–I
F. moniliforme 5		III–III	0–0–0–0	V–V–V–V	0–0–IV–I
F. moniliforme erumpens I		III–III	0–0–0	IV–II–0–III	I–0–0–I
F. moniliforme erumpens II		III–III	0–I–0	V–V–IV	I–II–II–I
F. moniliforme minus		III–III	0–0–I–0	V–V	0–0–V–V
F. moniliforme subglutinans		III–III	0–I–0–0	IV–V–III–III	I–0–IV–0
F. neoceras	I–I	0–0	0–0–0–0	III–0–III–II	0–0–I–I
F. niveum 1		II–III	0–0–0–0	V–V–V	III–III–III
F. niveum 2		III–IV	0–0–0–0	V–V–V	III–II–III–V
F. orthoceras		III–IV	0–0–0–0	V–V–V	0–0–V–V
F. orthoceras triseptatum		V–V	II–II–0–0	IV–V–V–V	0–0–V–III
F. ossicolum 1	V–V	0–0–0	0–0–0–0	II–II–III	0–0–III–0
F. ossicolum 2	III–III	0–0	0–0–0–0	V–IV–III–0	0–0–0–0
F. oxysporum 1		III–III	I–I–0–0	V–V–V–I	I–0–0–II–V
F. oxysporum 2		IV–IV	0–I–I–I	V–V–II–V	0–0–I–V
F. oxysporum nicotianae		IV–IV	II–II–II–II	V–V–V–V	0–0–0–0–IV
F. paspalicola	0–IV–0–0	0–0	0–0–0	IV–0–IV–IV	0–0–0–0

TABLE 10.—(*Continued*)

Organism	Tribromphenol sodium salt			Sodium 2.4 dinitrophenoxide	
	0.001%	0.0025%	0.005%	0.01%	0.02%
F. pirinum	V–V	0–0	0–0–0	V–II–II–II	0–0–0–0
F. poae 1		V–V	0–I–0–I	V–V–III–III	I–II–II–I
F. poae II		II–II	0–0–0–0	V–V–0–0	0–I–0–I
F. polymorphum	V–V	0–0	0–0–0–0	IV–I–II–II	0–0–V–V
F. pusillum		V–V	I–I–I–I	V–V–V–V	V–0–0–V
F. radicicola		V–V	II–I–II	V–V–IV	II–IV–V–IV
F. rhizochromatistes		IV–V	II–0–0–II	V–V–V–V	II–0–0–I
F. rhizochromatistes microsclerotium		III–V	II–0–0–II	V–V–V–V	0–0–0–0
F. sambucinum 1		II–III	0–0–0–0	IV–V–V–V	V–I–I–V
F. sambucinum 2	V–V	0–0	0–0–0–0	II–II–I–V	0–0–0–0
F. scirpi	III–III	0–0	0–0–0	0–0–0–II	III–II–0–0
F. sclerostromaton		III–III	II–I–0–0	V–V–V–0	I–I–I–I
F. semitectum 1–I	III–III	0–0–0	0–0–0	III–V–IV	III–II–0–III
F. semitectum 1–II	0–III–0–0	0–0–0	0–0–0	V–V–III–0	0–0–0–II–0
F. semitectum 1–III	III–IV	III–III–III	0–0–0	III–III–III–III	IV–III–0–III–IV
F. semitectum 1–IV	0–0–0–0	0–II–0	0–0–0	V–III–II–II	0–0–0–I–0
F. semitectum 1–V	0–0–0–0	0–0–0	0–0–0	IV–0–0–0	0–0–0–0–III
F. semitectum 1–VI	0–0–0–0	0–0–0	0–0–0	V–V–0–II	0–0–0–II–II
F. semitectum 1–VII	0–II–0–0	0–0–0	0–0–0	IV–0–IV–III	0–0–0–II–III
F. semitectum 1–VIII	IV–V	III–IV–V	I–I–I–I	V–V–V–III	V–0–0–III
F. semitectum 1–IX	0–0–0–0	0–0–0	0–0–0–0	III–III–IV–IV	0–0–0–0–IV
F. semitectum 1–X	V–V	0–I–I	0–0–0	III–0–III	0–0–0–0–II
F. semitectum 1–XI	II–II	0–0–0	0–0–0	V–II–III–V	0–0–0–II–III
F. semitectum 1–XII	0–0–0–0	0–0–0	0–0–0–0	III–IV–III–II	0–0–0–II–0
F. semitectum 1–XIII	0–II–0–0	0–0–0	0–0–0	V–V–V–0	0–0–0–V–0
F. semitectum 1–XIV	0–0–0–0	0–0–0	0–0–0–0	III–III–II–III	0–0–0–I–0
F. semitectum 1–XV	0–0–0–0	0–0–0	0–0–0	0–III–0–0	0–0–0–0–0
F. semitectum 1–XVI	0–0–0–0	0–0–0	0–0–0	IV–IV–0–0	0–0–0–II–0
F. semitectum 1–XVII	IV–V	I–I–I	0–0–0–0	III–V–IV–III	0–0–0–II–III
F. semitectum 1–XVIII	V–V	I–0–I	0–0–0–0	0–0–III–II	0–0–0–0–0
F. semitectum 2		I–II	0–0–0–0	III–III–IV–III	IV–0–0–III–IV
F. solani 1		V–V	II–0–0–0	V–V–V	V–V–V
F. solani 2–I		V–V	I–II–II–II	V–V–V–V	0–0–0–III

TABLE 10.—(*Continued*)

Organism	Tribromphenol sodium salt			Sodium 2.4 dinitrophenoxide	
	0.001%	0.0025%	0.005%	0.01%	0.02%
F. solani 2–II		V–V	II–II–II–II	IV–IV–IV–V	IV–V–IV–IV
F. solani 3–I		V–V	I–I–I–I	V–V–V–V	V–V–II–V
F. solani 3–II		II–II	0–I–I–I	V–V–V	I–II–III–I
F. solani 3–III		II–III	0–I–I–I	V–V–V–V	V–II–II–II
F. solani 4–I	V–V	0–0	0–0–0	V–V–V	0–0–I–I
F. solani 4–II		V–V	0–0–0	V–V–V	V–V–III–III
F. solani minus 1–I		III–III	II–II–II–II	V–V–V	V–II–I–II
F. solani minus 1–II		II–III	0–0–I–0	V–V–III	I–I–II–II
F. solani minus 2–I		V–V	I–III–II–IV	V–V–V–V	V–V–II–V
F. solani minus 2–II		II–III	0–0–I–0	V–V–V	II–II–II–V
F. solani suffuscum		II–II	0–0–0	V–III–V	II–II–II–III
F. spinaceae 1		V–V	II–0–I–II	V–V–V	III–III–III–V
F. spinaceae 2		III–III	0–I–I–II	V–V–V	V–V–IV–V
F. striatum 1–I		V–V	I–II–II–II	V–V–V	I–II–0–III
F. striatum 1–II		V–V	I–I–I–I	V–V–V	I–I–IV–I
F. striatum 2		V–V	II–II–II–II	V–V–V	IV–IV–V–V
F. striatum 3–I		III–III	0–II–0–I	V–V–V	II–I–III–V
F. striatum 3–II		IV–IV	0–II–0	V–V–V	II–II–I–III
F. sulphureum 1	V–V	I–I–III	0–0–0–0	V–0–V–V	0–0–0–0
F. sulphureum 2	III–III	0–0	0–0–0–0	III–III–IV–III	0–0–0–0
F. sulphureum 3		II–II	0–0–0–0	III–IV–0–III	0–0–II–0–0
F. theobrome		II–II	0–I–0–0	V–V–V–V	0–0–II–II
F. tracheiphilum		III–III	I–0–I–0	V–III–V–V	II–0–0–I
F. trichothecioides 1		IV–IV	0–0–0	V–V–V–V	0–I–II–0
F. trichothecioides 2–I	I–0	0–0	0–0–0	IV–IV–0–0	V–0–0–0–0
F. trichothecioides 2–II		II–I	0–0–0–0	III–0–III	0–0–0–0
F. trichothecioides 2–III	II–III	0–0	0–0–0	I–III–0–0–IV	0–0–0–0
F. trichothecioides 3–I	V–V	0–0	0–0–0	V–V–V–V	0–0–II–V
F. trichothecioides 3–II	V–V	0–0	0–0–0	0–0–V–V	0–0–0–0
F. trichothecioides 4–I	0–0–0–0	V–V–0–0	0–0–0–0	IV–V–III–V	0–0–0–0
F. trichothecioides 4–II		IV–IV	0–0–0–0	V–V–V–V	V–0–0–0
F. trichothecioides 5		III–III	0–0–0–0	II–V–V–II	0–0–III–III
F. trichothecioides 6		II–II	0–0–0	V–V–V	0–0–V–I
F. trichothecioides 7–I		II–II	0–0–0–0	V–V–V	0–0–0–I

TABLE 10.—(*Continued*)

Organism	Tribromphenol sodium salt			Sodium 2.4 dinitrophenoxide	
	0.001%	0.0025%	0.005%	0.01%	0.02%
F. trichothecioides 7–II	II–II	0–0	0–0–0–0	0–0–V–0	0–0–0–II
F. tricinctum 1–II	III–IV	0–0–0	0–0–0	II–II–II–I	I–I–0–I
F. tricinctum 1–III	III–III	II–III–0	0–0–0	0–0–II	0–0–0–0
F. tricinctum 1–IV	IV–IV	II–III–0	0–0–0	II–0–II–II	I–I–0–I
F. tricinctum 1–V	II–III	I–I–0	0–0–0	II–II–I–I	I–II–I
F. tricinctum 1–VI	III–IV	I–I–0	0–0–0	I–I–0–II	0–0–0–0
F. tricinctum 1–VII	II–III	0–0–0	0–0–0	0–II–I	I–I–I–I
F. tricinctum 1–VIII	III–I	I–0–0	0–0–0	0–0–II–0	0–0–0–0
F. tricinctum 1–IX	IV–III	I–II–0	0–0–0	II–III–I–II	0–0–0–0
F. tricinctum 2	III–III	0–I	0–0–I–0	II–0–V–II	0–0–I–0
F. uncinatum		II–II	0–0–0	III–IV–III–IV	0–0–I–I
F. urticearum I	0–I–0–0	0–0	0–0–0	I–0–II–0	0–0–0–0
F. urticearum II	I–0–0–0	0–0	0–0–0	II–I–0–0	0–0–I–0
F. vasinfectum		I–III	0–0–0–0	V–V–II–V	I–II–III–I
F. viride 1		V–V	I–II–II–II	V–III–IV	V–V–I–IV
F. viride 2		I–II	0–0–0–0	V–V–III–V	0–II–I–IV
F. viticola		I–II	0–0–0–I	III–III–III–III	0–0–III–III
F. zonatum 1		II–II	I–0–0–0	V–V–IV–III	I–0–0–II
F. zonatum 2		III–III	I–0–0–I	III–III–V–III	I–II–0–I–II
F. zonatum 3		III–III	I–II–II–II	III–III–III–III	III–III–II–II

GROWTH IN PRESENCE OF IODIC ACID AND PHENYL ACETIC ACID

Two concentrations of iodic acid (0.05 and 0.075 per cent) and one concentration of phenyl acetic acid (0.03 per cent) have been used in this experiment. Fusaria exhibit a very narrow margin of toleration to these substances, especially to phenyl acetic acid. 0.1 per cent of iodic acid inhibited the growth in nearly every one of the strains tested. 0.05 per cent of phenyl acetic acid had a similar action, but when its concentration was lowered to 0.02 per cent, such a large number of organisms made a vigorous growth that it was not found worthwhile to include the results in Table 11.

It is not necessary to make a detailed analysis of table 11, because it illustrates, although in a somewhat different way, the same principle revealed by all the foregoing tables, namely, that individual strains may vary greatly within the sphere of the same species, that each individual may vary within its own life period, that fluctuation is the most constant characteristic of these organisms, and that attempts at standardization may never be very fruitful.

The responses towards iodic acid were tested further in case of the more erratic strains, and their reactions, more conflicting than ever, are given below:

DISCUSSION

The foregoing tables show that the extreme variability and inconstancy which exist within the strains of the same species, and within the successive reactions of the same organism, preclude the possibility of developing a simple scheme of classification. We have seen that rate of growth, color of substratum and mycelium, type of fruiting, presence and absence of different kinds of spores, temperature relations, and reactions towards acids, dyes, and toxic substances are not constant. To the superficial observer this may appear as a hopeless situation, but a closer analysis of the experimental data reveals that a characteristic line usually maintains its course throughout such inconsistencies and unorthodox behaviors.

Let us consider, for example, the five strains of *F. martii phaseoli*. Strains 1–I, 1–III, and 2–I form pigments, 1–II and 2–II do not; strains 1–I and 2–I produce an abundance of sporodochia, the remainder do not; strains 1–I, 1–III, 2–I, and 2–II form no microconidia, while 1–II does. Strain 1–III is the only one that remains sterile on malt extract agar, and 1–I and 2–I are the only ones capable of forming macroconidia. Strains 1–II and 2–I tolerate 0.25 per cent tannic acid, the remaining three do not. Strains 1–III and 2–II cannot grow in the presence of 0.001 per cent sodium tribromphenate. Strains 2–I and 2–II fail to grow in the presence of acid phenyl acetic. Strain 2–I is the only one that can grow at a temperature of 5° C. On the other hand, all five strains are slow growers, all are extremely

TABLE 11.—*Growth in presence of iodic acid and Phenyl acetic acid (2 weeks at 25° C.)*

Organism	Iodic Acid		Acid Phenyl Acetic
	0.05%	0.075%	0.03%
F. acuminatum 1	III–III–IV–V	0–0–0	V–II–0–0–III
F. acuminatum 2–I	V–IV–III–III	0–0–V	0–0–0–0
F. acuminatum 2–II	V–V–V–V	0–0–V	0–0–0–0
F. acuminatum 2–III	V–V–0–0	0–0–IV	0–0–0–0
F. acuminatum 2–IV	V–V–V–0	0–0–0	0–0–0–III–V
F. acuminatum 2–V	III–V–IV–III	II–II–0	0–0–0–III
F. acuminatum 2–VI	V–IV–V–0	0–0–0	0–0–0–0
F. acuminatum 2–VII	V–V–V–0	0–0–0	0–0–0–0
F. acuminatum 2–VIII	IV–V–0–0	0–0–0	0–0–0–0
F. alluviale	II–II–I–0	0–0–0	V–0–0–V–V
F. anthophilum	III–V–I–0	0–0–0	0–0–0–I–II
F. aquaeductuum pusilum	III–I–III–II	0–0–0	0–0–0–II–II
F. aquaeductuum volutum	I–0–I–0	0–I–0	0–0–0–II–II
F. arcuatum	V–V–IV	0–0–IV	0–0–0–III–V
F. asclerotium	V–IV–0	IV–0–V	V–V–III–IV
F. aurantiacum	IV–V–V–IV	0–0–V	V–V–V–V
F. batatatis 1	0–0–I	0–0–0	V–V–V–V
F. batatatis 2	IV–V–V–V	0–0–V	V–IV–III–V
F. bulbigenum	IV–V–V–V	0–V–V	V–V–V–V
F. bullatum I	IV–IV–V–V	0–0–V	0–0–0–0–V
F. bullatum II	V–IV–IV–V	0–IV–V	V–V–0–IV–IV
F. bullatum brevius	V–V–V–V	0–IV–IV	V–V–V–V
F. camptoceras I	IV–IV–IV–IV	0–0–IV	0–0–0–IV–V
F. camptoceras II	IV–IV–III–IV	IV–0–0	0–0–0–IV–IV
F. caudatum	IV–IV–0–0–0	0–0–V	V–IV–0–0–0
F. chlamydosporum I	V–V–V–0	0–0–IV	I–0–0–0–0
F. chlamydosporum II	0–III–III–III	0–0–0	II–II–0–0–II
F. chlamydosporum III	V–V–III–V	0–0–IV	0–0–0–0
F. chenopodinum	III–IV–0–IV	0–0–0	0–0–0–III–0
F. coeruleum 1–I	I–0–II–I	0–0–0	IV–IV–IV–V
F. coeruleum 1–II	0–0–0–0	0–0–0	V–V–IV–V
F. coeruleum 2	II–II–V–0	0–0–0	V–V–V–III
F. coeruleum 3	0–0–V–0	0–0–0	0–0–0–0
F. commutatum	II–I–I–0	0–0–0	0–0–0–0
F. conglutinans	V–V–V–0	V–0–0	V–V–IV–V
F. cubense 1	V–V–V–V	0–V–V	V–V–0–V
F. cubense 2	V–V–0–V	V–0–V	V–III–III–V
F. culmorum 1–I	V–0–V–0	0–0–0	0–0–0–0
F. culmorum 1–II	0–0–V	0–0–IV	0–0–0–0
F. culmorum 2	V–V–0–0	V–0–0	0–0–0–0
F. culmorum 3–I	0–V–0–0	I–IV–V	0–0–V–V
F. culmorum 3–II	V–IV–0–0	0–0–0	0–0–II–III
F. culmorum 4–I	V–0–V–V	0–0–III	V–0–0–I
F. culmorum 4–II	IV–IV–III–0	0–0–V	II–I–0–0–0
F. culmorum 5	V–V–V–0	0–0–I	IV–IV–V–0
F. culmorum 6–I	V–V–V–0	V–V–V	V–V–V–V
F. culmorum 6–II	V–V–III–II	V–0–0	V–V–V–V
F. decemcellulare	V–V–0–0–0–0	0–0–0	0–0–0–III–V
F. dimerum	V–V–V–0	V–0–0	V–I–0–0–0
F. diversisporum	V–V–V–0	V–0–0	V–V–IV–V
F. ensiforme	0–0–0–0	0–0–0	0–0–0–0
F. eumartii 1–I	0–0–0–0	0–0–0	0–0–II–0–0
F. eumartii 1–II	I–0–0–I	0–0–0	V–V–V–V
F. eumartii 2–I	III–I–0	0–0–0	0–0–II–V
F. eumartii 2–II	0–V–I–V	0–0–0	II–I–0–0–0
F. eumartii 3	0–V–I–0	0–0–0	0–0–0–II–III

TABLE 11.—(*Continued*)

Organism	Iodic Acid		Acid Phenyl Acetic
	0.05%	0.075%	0.03%
F. euoxysporum	V–0–V–V	0–0–V	V–V–IV–V
F. falcatum	V–V–V–0	V–0–0	0–0–0–0
F. filiferum I	IV–V–IV–V	0–0–III	V–IV–0–0–V
F. filiferum II	IV–IV–0	V–V–IV	0–0–V–0–0
F. flocciferum	V–0–0–0	0–0–0	V–V–V–V
F. fructigenum	III–V–V–0	0–0–0	IV–IV–V–0–0
F. fructigenum maius 1	V–V–V–V	V–V–V	IV–IV–V–V
F. fructigenum maius 2–I	V–V–V–IV	0–0–0	V–V–0–V
F. fructigenum maius 2–II	IV–V–V	0–V–0	IV–IV–IV–V
F. fructigenum maius 2–III	V–V–V–0	0–0–0	V–V–V–V
F. fructigenum maius 2–IV	V–V–V–0	0–0–0	V–V–IV–V
F. fructigenum maius 2–V	V–IV–0	0–III–I	V–V–III–V
F. fructigenum maius 2–VII	0–0–0–0	0–0–0	V–V–0–V
F. fructigenum maius 2–VIII	V–0–V–0	0–0–0	V–III–V–V
F. fructigenum maius 3–I	V–V–V	0–0–0	0–0–0–V–V
F. fructigenum maius 3–II	V–II–V	0–0–0	0–0–0–V–V
F. fructigenum maius 3–III	V–0–V–V	0–0–I	0–0–0–IV–V
F. gibbosum	IV–V–V–V	0–0–V	IV–V–0–III
F. graminum 1	0–0–V–0	0–I–V	0–0–0–0–V
F. graminum 2–I	III–V–V–0	V–V–0	0–0–0–II–V
F. graminum 2–II	V–V–V–0	0–0–III	0–0–0–V–III
F. herbarum 1	III–III–IV–III	0–II–0	II–0–0–V
F. herbarum 2	V–V–IV–V	0–III–0	III–II–V–V
F. herbarum pirinum I	IV–V–V–0	0–II–0	V–V–V–V
F. herbarum pirinum II	II–IV–V–0	0–0–0	III–III–III–V
F. herbarum gibberalloides I	IV–V–V–IV	0–0–0	V–V–0–III
F. herbarum gibberalloides II	V–IV–V	0–0–0	III–III–IV–IV
F. hyperoxysporum 1	V–V–V	0–0–V	V–V–V–V
F. hyperoxysporum 2	V–V–V	IV–IV–V	IV–IV–IV–IV
F. incarnatum I	V–V–IV–V	V–IV–IV	V–V–IV–IV
F. incarnatum II	III–IV–IV–III	III–0–0	V–V–0–V
F. incarnatum IV	III–IV–I–II	0–III–V	0–0–III–IV
F. incarnatum V	III–III–0–III	IV–II–IV	IV–IV–0–0
F. javanicum 1	II–0–0–0	0–0–0	V–V–V–V
F. javanicum 2	V–V–V–0–0	V–V–0	II–0–0–V–V
F. lateritium I	V–IV–0–0	0–0–0	0–0–II–III
F. lateritium II	V–0–V–0	0–0–I	0–0–0–II–V
F. lini	I–I–0	0–0–0	V–V–V–V
F. lolii	I–0–0	0–0–0	0–0–0–0–0
F. loncheceras	V–V–V–V	0–0–V	V–V–IV–V
F. loncheceras microsporum	V–V–V–0	0–0–V	V–V–IV–IV
F. longipes	V–V–V–0	II–0–0	0–0–0–0
F. lutulatum I	IV–V–IV–IV	IV–IV–IV	III–III–0–0–0
F. lutulatum II	III–V–IV–IV	IV–0–0	IV–IV–IV–III
F. lycopersici 1	V–V–0–0	0–0–IV	V–V–V–V
F. lycopersici 2	V–V–V–0	V–0–V	V–V–V–V
F. malli	V–V–V–0–0	V–V–V	IV–V–IV–IV
F. macroceras	III–0–0–0	0–0–0	0–0–0–0
F. martii 1	0–0–0	0–0–0	V–V–V–V
F. martii 2	V–V–V–V	V–V–V	V–V–V–V
F. martii 3–I	0–0–0–I	0–0–0	III–III–II–V
F. martii 3–II	0–0–0–0	0–0–0	V–V–III–III
F. martii minus	II–II–II–0	0–0–0	V–V–V–V
F. martii phaseoli 1–I	I–0–II–I	0–0–0	IV–I–0–0–0
F. martii phaseoli 1–II	0–0–0–0	0–0–0	V–V–III–II–V
F. martii phaseoli 1–III	0–0–0–0	0–0–0	V–V–0–II–II

TABLE 11.—(*Continued*)

Organism	Iodic Acid		Acid Phenyl Acetic
	0.05%	0.075%	0.03%
F. martii phaseoli 2–I	0–0–0	0–0–0	0–0–0–0
F. martii phaseoli 2–II	0–0–V–0	0–0–0	0–0–0–0
F. martii pisi	V–V–V–V	0–V–V	IV–IV–IV–IV
F. martii viride	0–0–0–V	0–0–0	V–V–V–V
F. moniliforme 1	V–V–V–IV	V–IV–IV	IV–IV–IV–IV
F. moniliforme 2	V–V–V–0	0–V–V	V–V–V–V
F. moniliforme 3	V–V–V–V	0–0–0	V–IV–IV–II
F. moniliforme 4	V–0–V–V	0–V–V	V–V–V–V
F. moniliforme 5	V–V–V–V	V–0–V	IV–IV–II–V
F. moniliforme erumpens I	V–V–V	0–0–0	IV–IV–IV–IV
F. moniliforme erumpens II	V–0–IV	V–0–0	V–V–V–V
F. moniliforme minus	V–V–V	IV–IV–V	V–V–V–V
F. moniliforme subglutinans	V–V–V–0	0–0–0	V–V–V–V
F. ncoceras	V–V–V–V	0–0–0	V–V–IV–V
F. niveum 1	V–V–IV–IV	V–0–0	III–III–0–III
F. niveum 2	V–0–0–0	V–0–0	V–V–V–V
F. orthoceras	V–V–V–0–V	0–0–V	V–V–V–V
F. orthoceras triseptatum	V–IV–V–0–IV	0–V–V	V–V–0–V
F. ossicolum 1	IV–IV–III	IV–IV–IV	0–0–0–IV–IV
F. ossicolum 2	V–IV–V–0	0–V–0	0–0–0–0–0
F. oxysporum 1	V–V–V	0–V–V	V–V–V–V
F. oxysporum 2	V–V–V	0–0–0	V–V–V–V
F. oxysporum nicotianae	V–V–V	0–V–V	V–IV–IV–IV
F. paspalicola	0–0–II–0	0–0–0	0–0–0–0
F. pirinum	V–V–V–0	0–0–0	0–0–III–0
F. poae I	V–V–0–0–V	0–0–0	V–V–V–V
F. poae II	V–V–V–V	V–0–0	V–V–V–V
F. polymorphum	IV–I–V–0	0–0–0	II–II–IV–V
F. pusillum	0–0–V–0	0–0–0	V–III–0–V
F. radicicola	III–0–0	0–0–0	V–V–V–V
F. rhizochromatistes	V–V–V–V	V–0–V	V–IV–IV–V
F. rhizochromatistes microsclerotium	IV–V–V–0–0	0–0–V	0–V–IV–V
F. sambucinum 1	III–III–III–III	I–I–I	IV–IV–V–V
F. sambucinum 2	V–V–V–0	0–0–0	V–IV–III–I–0
F. scirpi	IV–IV–IV–0	0–II–V	III–III–0–II
F. sclerostromaton	V–V–0–V	0–0–0	V–IV–IV–V
F. semitectum 1–I	III–I–III–III	III–IV–V	V–V–0–0–0
F. semitectum 1–II	IV–V–IV–V	0–0–0	II–0–IV–0–0
F. semitectum 1–III	III–III–III–III	0–IV–III	IV–IV–IV–IV
F. semitectum 1–IV	V–III–III–IV	0–0–0	0–0–0–0
F. semitectum 1–V	V–V–0–0	0–0–0	0–0–0–III–V
F. semitectum 1–VI	V–0–V–0	0–0–0	0–0–0–0–0
F. semitectum 1–VII	IV–IV–III–V	0–II–0	IV–V–0–IV
F. semitectum 1–VIII	V–V–V–V	V–V–V	IV–IV–IV–IV
F. semitectum 1–IX	III–III–IV–IV	III–III–0	IV–IV–III–III
F. semitectum 1–X	V–V–0	V–IV–IV	V–0–0–0–V
F. semitectum 1–XI	V–V–IV–0	0–0–0	0–0–0–III–III
F. semitectum 1–XII	III–IV–III–V	0–0–0	0–0–0–V–V
F. semitectum 1–XIII	IV–0–V–V	0–0–0	IV–0–V–0
F. semitectum 1–XIV	III–IV–III–0	0–0–0	0–0–III–IV
F. semitectum 1–XV	III–III–V–0	0–0–0	0–0–0–0
F. semitectum 1–XVI	IV–IV–V–0	0–0–0	V–0–0–0–0
F. semitectum 1–XVII	V–IV–V–IV	0–0–V	IV–IV–III–V
F. semitectum 1–XVIII	V–IV–V–III	IV–IV–IV	V–IV–0–0–0
F. semitectum 2	III–III–III–III	IV–IV–IV	IV–IV–III–III

TABLE 11.—(*Continued*)

Organism	Iodic Acid		Acid Phenyl Acetic
	0.05%	0.075%	0.03%
F. solani 1	I–0–I–0	0–0–0	V–V–V–V
F. solani 2–I	V–V–V–0	V–V–V	V–V–V–V
F. solani 2–II	I–I–I–I	0–0–0	V–V–III–V
F. solani 3–I	0–IV–0–III	0–0–0	V–V–V–V
F. solani 3–II	0–0–I	0–0–0	V–V–V–IV–III
F. solani 3–III	V–V–III	0–0–0	V–V–V–IV–V
F. solani 4–I	III–II–II	0–0–0	IV–V–III–V
F. solani 4–II	III–III–V–0	0–0–0	III–III–III–V
F. solani minus 1–I	0–V–0–0	0–0–0	II–II–V–V
F. solani minus 1–II	I–I–0–0	0–0–0	V–V–III–V
F. solani minus 2–I	II–0–0	0–0–0	V–V–V–V
F. solani minus 2–II	0–0–0	0–0–0	III–IV–V–V
F. solani suffuscum	V–III–I–0	0–0–0	V–IV–IV–V
F. spinaceae 1	V–V–V–0	0–0–V	IV–V–IV–V
F. spinaceae 2	V–V–V–V	V–0–0	V–V–V–V
F. striatum 1–I	II–I–I–0	0–0–0	II–III–V–V
F. striatum 1–II	0–0–0–0	0–0–0	III–II–V–V
F. striatum 2	0–0–0–0	0–0–0	V–V–IV–V
F. striatum 3–I	I–0–0–0	0–0–0	V–V–V–V
F. striatum 3–II	0–0–I	0–0–0	V–V–V–V
F. sulphureum 1	V–0–V–V	0–0–0	IV–IV–0–0–0
F. sulphureum 2	III–III–IV–III	0–0–III	0–0–0–II–III
F. sulphureum 3	IV–IV–IV–IV	0–0–0	0–0–IV–IV
F. theobrome	0–0–0–0	0–0–0	I–II–V–III–IV
F. tracheiphilum	V–V–V–0	V–V–V	V–II–III–V
F. trichothecioides 1	III–V–IV–V	0–0–0	IV–IV–IV–V
F. trichothecioides 2–I	I–0–V–0	V–0–0	IV–0–0–0–0
F. trichothecioides 2–II	III–IV–0	0–0–0	V–V–0–0–IV
F. trichothecioides 2–III	IV–V–V–V	V–0–0	0–0–0–0–0
F. trichothecioides 3–I	V–V–V–V	V–0–0	0–0–0–0
F. trichothecioides 3–II	V–V–V–0	0–0–V	0–0–0–0
F. trichothecioides 4–I	0–0–0	0–0–0	0–0–0–0
F. trichothecioides 4–II	IV–V–IV	0–0–0	III–0–0–0–0
F. trichothecioides 5	V–V–0–0–0	0–0–V	V–V–III–V
F. trichothecioides 6	V–V–V–V	0–0–V	V–V–V–V
F. trichothecioides 7–I	0–I–0–0	0–0–0	III–II–I–V
F. trichothecioides 7–II	0–V–V–0	0–0–0	0–0–V–0
F. tricinctum 1–III	III–0–III	0–0–0	V–III–0–II
F. tricinctum 1–IV	III–0–0–0	I–0–0	III–0–0–III
F. tricinctum 1–V	V–V–0–0	0–0–0	V–V–II–V
F. tricinctum 1–VI	III–V–0–V–0	0–0–0	0–0–III–IV
F. tricinctum 1–VII	0–V–0	0–0–0	II–0–0–IV
F. tricinctum 1–VIII	0–0–0–0	0–0–0	II–0–0–III
F. tricinctum 1–IX	III–0–0–0	III–0–0	0–0–0–III–IV
F. tricinctum 2	III–III–IV–III	0–0–0	III–II–II–IV
F. uncinatum	IV–V–V–0	0–0–0	III–III–II–III
F. urticearum I	0–IV–V–0	0–0–0	0–0–0–0
F. urticearum II	V–III–0–0	0–0–0	0–0–0–II
F. vasinfectum	V–V–V–V	0–0–0	V–IV–IV–V
F. viride 1	0–0–0–0	0–0–0	V–V–V–V
F. viride 2	V–0–V–0	I–V–V	V–V–0–IV
F. viticola	III–I–III–0	I–0–0	IV–IV–III–III
F. zonatum 1	IV–V–V–0	0–0–0	V–V–III–IV
F. zonatum 2	IV–V–V–V	V–V–V	IV–IV–IV–III–IV
F. zonatum 3	V–V–V–0	V–0–0	IV–III–III–IV

F. asclerotium → 0.05 per cent iodic acid = V / IV / 0
0 → nutrient solution = 0

F. alluviale → 0.05 per cent iodic acid = II / II / I
0 → nutrient solution = 0

F. anthophylum → 0.05 per cent iodic acid = III / V / I
0 → nutrient solution = 0

F. coeruleum 2 → 0.025 per cent iodic acid = II / II / V
0 → nutrient solution = V → agar → 0.05 per cent iodic acid = III / II / I

F. coerulem 3 → 0.05 per cent iodic acid = 0 / 0 / V
0 → nutrient solution → = 0

F. culmorum I → 0.05 per cent iodic acid = V / 0 / V
0 → nutrient solution = 0

F. conglutinans → 0.05 per cent iodic acid = V / V / V
0 → nutrient solution = 0

F. chlamydosporum I → 0.05 per cent iodic acid = V / V / V
0 → nutrient solution = 0

F. commutatum → 0.05 per cent iodic acid = II / I / I
0 → nutrient solution = V → agar → 0.05 per cent iodic acid = 0 / 0 / 0

F. dimerum → 0.05 per cent iodic acid = V
V
V
0 → nutrient solution = 0

F. diversisporum → 0.05 per cent iodic acid = V
V
V
0 → nutrient solution = 0

F. decemcellulare → 0.05 per cent iodic acid = V
V
0
0 → nutrient solution = V → agar → 0.05 per cent iodic acid = 0
0
0

F. eumartii 2–I → 0.05 per cent iodic acid = III
I
0 → nutrient solution = 0

F. eumartii 2–II → 0.05 per cent iodic acid = 0
V
I
V → agar → 0.05 per cent = 0
0 → nutrient solution = 0
V → agar → 0.05 per cent idodic acid = 0
0
0

F. falcatum → 0.05 per cent iodic acid = V
V
V
0 → nutrient solution = 0

F. filiferum II → 0.05 per cent iodic acid = IV
IV
0 → nutrient solution = 0

F. flocciferum → 0.05 per cent iodic acid = V
0
0
0 → nutrient solution = 0

F. fructigenum → 0.05 per cent iodic acid = III
V
V
0 → nutrient solution = 0

F. fructigenum maius 2–III →0.05 per cent iodic acid = V
V
V
0 → nutrient solution = 0

F. fructigenum maius 2–IV → 0.05 per cent iodic acid = V
V
V
0 → nutrient solution = 0

F. fructigenum maius 2–V → 0.05 per cent iodic acid = V
IV
0 → nutrient solution = 0

F. fructigenum maius 2–VIII → 0.05 per cent iodic acid = V
0
V
0 → nutrient solution = 0

F. gibbosum → 0.05 per cent iodic acid = IV
V
V
V → agar → 0.05 per cent = 0
0 → nutrient solution = 0

V → agar → 0.05 per cent iodic acid = 0
0
III

F. javanicum 2 → 0.05 per cent iodic acid = V
V
0
0 → nutrient solution = 0

F. lolii → 0.05 per cent iodic acid = I
0
0 → nutrient solution = 0

F. longipes → 0.05 per cent iodic acid = V
V
V
0 → nutrient solution = 0

F. lycopersici 1 → 0.05 per cent iodic acid = V
V
0
0 → nutrient solution = 0

F. macroceras → 0.05 per cent iodic acid = III / 0 / 0 → nutrient solution = 0

F. malli → 0.05 per cent iodic acid = V / V / 0 → nutrient solution = 0

F. martii phascoli 2–II → 0.05 per cent iodic acid = 0 / 0 → nutrient solution = 0

F. martii viride → 0.05 per cent iodic acid = 0 / 0 / 0 → V → agar → 0.05 per cent iodic acid = 0 / 0 → nutrient solution = V → agar → 0.05 per cent iodic acid = 0 / 0 / 0

F. moniliforme 2 → 0.05 per cent iodic acid = V / V / V → 0 → nutrient solution = 0

F. moniliforme crumpens II → 0.05 per cent iodic acid = V / 0 / IV → nutrient solution = 0

F. moniliforme subglutinans → 0.05 per cent iodic acid = V / V / V → 0 → nutrient solution = 0

F. orthoceras → 0.05 per cent iodic acid = V / V / 0 → V → agar → 0.05 per cent iodic acid = V / V / V

F. ossicolum 2 → 0.05 per cent iodic acid = V / IV / V → 0 → nutrient solution = 0

F. polymorphum → 0.05 per cent iodic acid = IV / I / V
0 → nutrient solution = 0

F. pusilum → 0.05 per cent iodic acid = 0 / 0 / V
0 → nutrient solution = V → agar → 0.05 per cent iodic acid = 0 / 0 / 0

F. rhizochromatistes microsclerotium → 0.05 per cent iodic acid = IV / V / V / 0
0 → nutrient solution = 0

F. semitectum 1–V → 0.05 per cent iodic acid = V / V / 0
0 → nutrient solution = 0

F. semitectum 1–X → 0.05 per cent iodic acid = V / V
0 → nutrient solution = 0

F. semitectum 1–XIII → 0.05 per cent iodic acid = 0
V → agar → 0.05 per cent iodic acid = 0 / 0 / 0
0 → nutrient solution = 0

F. scirpi → 0.05 per cent iodic acid = IV / IV / IV
0 → nutrient solution = 0

F. sclerostromaton → 0.05 per cent iodic acid = V / V / 0 / V
V → agar → 0.05 per cent iodic acid = V / V / V

F. solani 4–II → 0.05 per cent iodic acid = III / III / V
0 → nutrient solution = V → agar → 0.05 per cent iodic acid = 1 / 1 / 0

F. solani 3–I → 0.05 per cent iodic acid = 0 / IV / 0

III → agar → 0.05 per cent iodic acid = 0 / 0 / 0 → nutrient solution = V → agar → 0.05 per cent iodic acid = 0 / 0 / 0

F. solani minus I → 0.05 per cent iodic acid = 0 / V / 0 → agar → 0.05 per cent iodic acid = 0 / 0 / 0

F. solani suffuscum → 0.05 per cent iodic acid = 0 / V / III / I

0 → nutrient solution = 0

F. sambucinum 2 → 0.05 per cent iodic acid = V / V / V

0 → nutrient solution = 0

F. tricinctum 1–VI → 0.05 per cent iodic acid = V / III / V / 0

0 → nutrient solution = 0

F. trichothecioides 5 → 0.05 per cent iodic acid = V / V / 0

0 → nutrient solution = 0

F. zonatum 1 → 0.05 per cent iodic acid = IV / V / V

0 → nutrient solution = 0

sensitive to tartaric acid, all tolerate comparatively high concentrations of malachite green, mercurochrome, and sodium dinitrophenoxide, all are sensitive to iodic acid, and finally all fail to grow at 37.5° C. If we add to these similarities of behavior the known morphological and pathological relationships of these organisms, no one will doubt that, regardless of a number of important dissimilarities, all these strains really belong to the same species. Such is the case with the great majority if not all of the strains used in this work.

The present scheme of classification of Fusaria is very largely based on the morphology of the spores, especially that of the macroconidia. It must therefore follow that before an identification can be made, macroconidia must be produced. Here again the worker may sometimes find himself confronted by all sorts of difficulties. A glance at table 8 will show that there is a marked variation between the strains of the same species in their ability to form the three types of spores. It may be argued that only one kind of nutrient agar can hardly be expected to bring out all of the spores in all of the strains. Very true; it is even quite permissible to extend this statement and say that not even half a dozen or a dozen different agars can promote perfect sporulation in all strains. There always will be the same baffling contrast of sterility, partial sterility, and abundant sporulation exhibited within the limits of the same species. What is the investigator to do if a species of Fusarium constantly fails to produce macroconidia? Even if he finally does find a medium on which all three or any one of the desired spores will be produced, how will it be possible to make an identification unless the measurements of the corresponding type species are also made from the spores produced on the same medium? If a subculture of the type species is secured, what probability is there that it will sporulate on this agar? And, if it does sporulate, what are the exponents of "natural conditions" going to say about the use of artificial propagation? How is the worker to know that the culture is pure, that it has not mutated, has not "degenerated" by being carried on artificial media? And above all, who is going to make any one strain the ruling force within the specific orbit? Why should not another strain be just as typical and worthy of the honored status of type specimen? Furthermore, what is the value of spore measurements unless all conditions are standardized?

Size and shape factors are extremely flexible and vitally affected by the presence of various chemical substances in their food as shown by Brown and Horne (2). An examination of almost any illustration of Fusarium spores reveals the same thing. The macroconidia of *F. camptoceras*, from 8-day cultures on hard potato agar, as illustrated by Reinking and Wollenweber (8) and those from 15-day-old cultures on hard potato agar, are not at all alike. In *F. anguoides* the differences become still sharper when the

illustrations of the conidia from the mycelium of 1-month-old potato-plug cultures are compared with those of conidia obtained from the pionnotes of 18-day-old oatmeal agar, or 1-month-old rice cultures. In *F. longipes,* even a layman can tell that the illustrations of macroconidia taken from the pionnotes of 3-month-old hard potato-agar cultures have nothing in common with the drawings of macroconidia taken from the sporodochia of 1-month-old Alnus-stem cultures. Such more or less sharp differences can be seen in many illustrations of Fusaria when different substrata are used for food. Such being the case, it is quite a doubtful procedure to depend upon spores which may be produced by the use of different agars. It is improbable that one will ever be able to find a universal medium on which all Fusaria will readily reproduce the desired types of spores; and, yet, without standardized and uniform environmental conditions no morphological work can be so conclusive or convincing as one might desire.

Since differences in composition of food are capable of materially altering the size and the form of spores, it is logical to assume that different hosts with their still more complex chemical and physical makeup cannot fail to affect the morphology of the fungus. Nor are we in a position to state that in nature the constant and fierce competition for food does not complicate matters still further. How do the by-products of secondary invaders, such as fungi, bacteria, or protozoa, affect the composition of the host tissue? Since such by-products differ with different organisms, and since no one can seriously say that secondary invaders are always the same regardless of host or locality, the inevitable conclusion is that controlled laboratory conditions are more conducive to uniform sporulation. But can one be justified in discarding morphological factors just because no universal substratum can be found on which free sporulation of all strains of Fusaria will occur? Not at all.

But here is where the value of physiological tests becomes apparent. If the standard agars at our disposal fail to induce the formation of the desired type of spores, some physiological reaction may prove very useful in the identification of the unknown, and no long, often fruitless, search need be necessary for a medium capable of promoting conidium formation. The morphologists are beginning to realize this and employ certain laboratory tests as reliable criteria in their identification keys.

As fungi are studied more and more intensively, and new varieties and forms are every day being identified, the need for additional means of segregation becomes gradually more acute. We may admit that individual variations always will exist, that the intensity of such variations may tend to shape our conception of a true species. We may even go so far as to admit that very often the species may be nothing more than a clumsy device created for our own convenience, that its value may be directly proportional to

the degree of our own ignorance concerning the potentialities of the living protoplasm, yet we cannot get away from the fact that we must put either a true or an arbitrary limitation around some sort of a species sphere, making the species tests sufficiently numerous, conclusive, and flexible to define more clearly any distinct type of organism that we may need to identify. But before such a series of tests can be evolved, a more thorough study of the different strains of the species should be made.

No species is unlimited in its potential possibilities, nor do its variations usually fail to confine themselves to a certain sphere. It becomes the duty of the investigator to approach these boundaries by testing a very large number of individuals. By developing a great number of simple and effective tests, he should be able to construct a scheme whereby the mean of the specific reactions can be reached. After a sufficient amount of data are accumulated, it will not be difficult to select the more comprehensive tests and standards, and discard doubtful or less desirable ones. This sort of work has been thoroughly done in morphology, but in the study of physiological characters, the surface has been barely scratched. The present work is merely a step in this direction and no more. Much additional research is necessary before it can emerge from its formative stage and assume a more directive character. Many additional tests, if developed in the right direction, should relieve the strain that is being put upon morphological methods by the constant appearance of new forms or new variations. If such tests are sufficiently numerous and reliable, the proportion of "misfits" will be reduced to the minimum; for, after all, no organism can vary indefinitely, and its general behavior rarely, if ever, can jump the boundaries of the species.

The underlying causal factors responsible for the variability and inconsistencies of Fusaria may be roughly divided into external and internal groups. The external factors, themselves, are of two types: those which bring about temporary fluctuations without making any kind of impression upon the hereditary qualities of the protoplasm, and second, those that act as stimuli to awaken, stimulate, and perpetuate dissociative potentialities in the fungus. The internal factors are intimately concerned with the biological construction and mechanism of the protoplasm, and seem to bear little or no relationship to the usual environmental conditions. While the appearance of "sectors" in the colonies of Fusaria may not be considered mutations, yet, on the other hand, they can not be classified with the ordinary fluctuations because they appear and perpetuate themselves despite all attempts artificially to control them. It is true that even the most elaborately controlled laboratory conditions are comparatively crude, yet we can not hope to get completely away from our own physical limitations, and must, therefore, draw our conclusions from available data. The environ-

mental factors in the foregoing experiments have been controlled as rigidly as possible, yet the baffling fluctuations and endless inconstancies in the behavior of Fusaria have occurred so frequently and abundantly as to indicate conclusively that such variations cannot be ranked with ordinary fluctuations.

We cannot say that sector formation is due to food differences in a plate of agar because it is very difficult to conceive of such differences and because sectors develop even when the cultures are grown in a liquid medium where the distribution of sugars and salts is homogeneous. Furthermore, any fluctuation caused by food differences is bound to disappear as soon as normal conditions are reestablished. Yet, we find that many of the new characteristics persist for many generations after they have once been separated in pure culture. What is still more significant is the fact that differences arise not only in morphological characters but in vital physiological reactions as well. The same may be said about the possible presence or absence of certain essential elements in the medium. It should be remembered that only one solid agar was used throughout this work; the same quality and quantity of chemicals, the same amount of agar, the same environmental conditions were retained throughout the experiment. Yet even in duplicate and triplicate cultures some glaring inconsistencies continued to appear; one plate would show definite sectors while the others would remain uniformly the same irrespective of the fact that the same stock culture was used in the inoculation work. How can the presence or absence of certain food elements explain the fact that the new type, after being isolated in pure culture and breeding true for a few generations, will again split into a complex colony or revert to its prototype? No other nutrient agar was used, nothing was ever introduced that was not already there, yet reversions continued to occur. Furthermore, the writer has tested many combinations of chemicals with the hope of controlling sector formation, but without any success. Ultraviolet light, hard and soft X-rays and radium were tried with some of the most inconstant types, yet no outstanding effect could be observed. Twelve hours' exposure to the action of radium showed not the slightest change in the growth habit of the colonies. A fluctuating type of *F. moniliforme* was irradiated with X-rays at the rate of 10 and 20 minutes a day for two weeks, yet no change could be observed in its rate of growth, variability, general macroscopic appearance, and the ability to attack corn seedlings. It was also irradiated with ultraviolet light for an hour a day for two weeks, and the only noticeable effect even when a fluorescent dye was added to the medium, consisted of a slower rate of growth and as soon as the irradiation was discontinued the normal rate of growth was renewed.

The effect of the bacteriophage on bacteria, as described by d'Herelle (4) bears a remarkable parallelism with some of the variations recorded in

this paper, especially the reverting fluctuations. The Shiga bacillus, under the influence of bacteriophage, can change into coccus, mucoid, and ultramicroscopic types and become resistant to the attack of the bacteriophage. So long as the ultraparasite is present, the new types of Shiga bacillus persist, and even after the total removal of the bacteriophage they may breed true for a number of generations. Eventually, however, they revert back to the original bacillus type, lose their resistance to drying, to the age factor, and to the phage itself. The struggle between the bacteria and bacteriophage induces the emergence of these new types. It might be suggested that there is a sort of phage operating in Fusaria, but this seems improbable because the writer has observed no trace of lysis, no diminution of vigor, and no other sign except the baffling fluctuations.

All failure artificially to induce colony dissociations notwithstanding, a stimulus must exist in the environmental conditions before a response occurs on the part of the organism. Perhaps a number of factors can and do act as stimuli, but the reason why dissociations do not manifest themselves with unfailing regularity whenever stimuli are applied is that a constant state of flux exists in the protoplasm, and consequently the necessary coordination between the protoplasm and the proper environmental factor cannot be established except at certain intervals. All the cells of a given thallus are not in the same physiological and cyclogenic state, and just what controls such an evolution is not at all clear. Nor is it possible to state at what stage of development the most successful dissociative responses can be obtained. The fact that such dissociations do occur leads to the conclusion that a given spore is not a clearcut, standardized unit of known qualities, but that it is complex and is able, on germination, to change form and function and to perpetuate itself under various phases. A given organism may possess a number of phases. The eighteen strains of *F. semitectum* represent the eighteen phases in the cyclogeny of this particular organism. The writer seriously doubts if any of these and similar variants can remain immutable. Their degree of permanence should be a relative thing. Indeed, the very fact that some of them already have reverted to their original form indicates that we are dealing with the various stages of a complex organism rather than true mutations or truly new strains. On the other hand, there can be no doubt that owing to some favorable combinations of environmental factors some of these variants may perpetuate themselves indefinitely. It may be very difficult to identify life phases and true species or strains, unless each species is subjected to an intensive physiological study.

Even if one could demonstrate that food changes, bacteriophage, contamination with mites, Actinomyces, bacteria and other organisms, ultraviolet light and other waves, or any possible physical, chemical, or biological

factor or combinations of such factors might be the direct cause of mutations in fungi, this would still be of little significance taxonomically, because a given stimulus is valuable only in so far as it is able to awaken the hidden possibilities of the protoplasm. If there is nothing there to be awakened, then the stimulus itself remains as wasted energy unless it can be definitely shown that environment can put something into the protoplasm that originally was not there. The environment, therefore, can only hasten the appearance of the properties of the living protoplasm, just as X-rays probably hasten the mutation processes in the fruit fly or in the tobacco plant.

It may be said that under the "abnormal" conditions of the laboratory, where a fungus in pure culture finds no competition for food, and where the nutrient substances are in an entirely different and a more available form than are those found in nature, the fungus is more apt to find the necessary stimulus for the development of variants, and furthermore that, whereas in nature many such new forms would perish in the struggle for existence, under the tender care of the investigator they can be easily perpetuated. But, on the other hand, if an unusual stimulus is the cause of such variations (and the effect of X-rays and ultraviolet light in some animals, plants, and fungi seems to indicate that such might be the case) then where is such a stimulus more apt to be found, in the carefully controlled and simplified laboratory conditions or under the infinitely more complex natural conditions? When in a plate of agar a fungus colony develops sectors, it cannot escape the attention of the investigator. But, when such sectors are formed within the tissues of the host plant and are accidentally isolated in pure culture, they may be taken for distinct strains and their immediate relation to their parent types may not be suspected. Because the species concept in many of the lower organisms is based on too few and too indefinite characters, the investigator is very apt to go astray and take the different phases of a given species for new varieties at least. We have seen that dissociative changes affect a great many morphological and physiological characters which have been used in taxonomy as reliable criteria for differentiation. The writer regrets that he has been unable to find time for a careful study of the microscopic characters of the spores of the Fusaria, but he sees no reason why the spores should remain unaffected by dissociations when everything else seems to be more or less definitely altered. He has demonstrated that at least in case of *Phytophthora omnivora* the shape and size of sporangia are modified to such an extent in the so-called mutations as to make the new strains appear like species entirely different from their mother forms. But because the relationship of these strains to their prototype was known to the writer, he escaped the anomalous situation of having described as two species the strains of one organism. If the variants of Fusaria form an exception in which the shape and size of the spores is unaffected, they exhibit a rather singular biological behavior.

The inconsistency of physiological reactions as shown in all of the foregoing tables offers a better illustration of dissociative functions than the phenomenon of sector formation alone. When, for instance, three pieces of mycelium of equal age and size, obtained from the same colony and transferred to three different test-tubes, each tube containing the same quality and quantity of nutrient solution, yield three different kinds of reaction, it is very difficult to conceive of mere fluctuations as the causal factors. For example, what induces growth in one of the pieces of the mycelium, what is responsible for the total inhibition of the second piece, and why should the third piece be killed? And when the experiment is repeated, and the three similar pieces of mycelium are transferred to three test-tubes containing the same quality and quantity of nutrient solution, why should diametrically opposite results follow? Such conflicting and criss-crossing reactions have been listed by many dozens throughout this paper, and the experiments have been repeated time and again in duplicate and triplicate in order to eliminate all possible experimental error. Yet the same extreme fluctuation has constantly occurred, and it is not at all likely that such erratic responses could be caused by some oversight or mistake in laboratory procedure.

In addition to the experiments listed in this paper, a great many biochemical tests were conducted with these organisms, and the results obtained were so much more inconsistent that the writer was obliged to limit his work to comparatively stable tests. When variations in the vital phenomena of organisms occur under conditions as nearly controlled as possible, any explanation based on the theory of mere fluctuations is highly inadequate. If a portion of mycelium from the same colony grows readily in the presence of some inhibitive substance while another portion not only fails to grow but is killed, there is no doubt that the two pieces are not in the same physiological state but represent fairly distinct phases in the life of the colony. Dissociations of this type are readily induced by any substance which is capable of exerting an unusual or unfavorable action, as can be seen throughout the tables in this paper. We shall soon see that there is a very close parallelism in this respect between the behavior of Fusaria and that of a number of species of bacteria.

There seems to be a critical concentration of growth-inhibiting substances or factors in which the vital reactions barely balance themselves, and, dependent upon their physiological state the organisms either succeed in overcoming antagonistic action and grow, or are either inactivated or killed. That the quality and the efficiency of an organism is not uniform throughout the day is a well-known physiological fact, but as to what controls such variations, we are still in the dark. It is possible that not even the different parts of the protoplasm of a single cell are in the same state of development, because otherwise how can a single spore grow and dissociate

into different sectors and produce two, a dozen, or eighteen strains. A "pure" species, therefore, as we understand it, is a myth, because it may be composed of a great many phases which may be expressed under the action of the proper stimuli, and depending upon the environmental conditions, may either remain comparatively stable, or else may exhibit the sort of fluctuations that we have witnessed in the foregoing tables. The internal factors, which by their different combinations bring forth the specific characteristics of certain fungi, may be undergoing constant segregations and recombinations within the same protoplasm. At one time, due to one kind of combination a given cell may exhibit a characteristic which was not apparent before. The rapid proliferation of such a cell may produce sectors different from the rest of the colony, or give physiological responses unlike those of the mother type. Later, there may follow other segregations or recombinations, with the result that a reverse action follows and the old or a new type of growth may appear. This means that in reality an organism neither loses nor gains any characteristics, but because of a constant state of flux in the internal environment of the protoplasm, the different facets of the same organism are apt to appear or disappear depending upon the proper stimulus on the one hand and the evolution of the proper physiological state on the other. Perhaps many bona fide mutations, especially bud sports, result from this type of change in the internal environment of the protoplasm. Perhaps not even true mutants, if unprotected by selection, can remain immutable. Perhaps mutations are nothing more than variations or cyclogenic phases that have "jumped" a little farther.

The writer cannot believe that in all cases the different cyclogenic phases of a given species or strain lie dormant in the protoplasm until the proper stimulus comes along to activate them. It is probable that a colony which to the eye may appear purely uniform, or when subjected to laboratory tests may yield uniformly consistent reactions, may be, in reality, complex, and therefore "impure." There may be a decided masking effect operative within the colony. For instance, we know that upon opaque media such as oatmeal, sector formation is less common than upon transparent media; that thin layers of agar in the petri dish seem to induce sector formation while thicker layers fail to do so. Transparent or thin agars by themselves do not constitute stimuli, but because of their physical condition they aid the eye of the investigator to detect minute deviations from the dominant type. Sectors are not invariably clear-cut, nor can they always hold their own and grow into large sectors without being arrested or outgrown by the mother colony. Some media induce rank aerial growth, and when a sector with no aerial mycelium begins to appear, it is soon "smothered" under luxuriantly vegetating aerial hyphae. Such starchy substances as rice which induce pigment formation in the great majority of Fusaria are very poor substrata

upon which to search for pigment forming and non-pigment forming segments, whereas synthetic or semi-synthetic agars which can induce pigment formation in some varieties and hinder it in others, admirably serve for such a purpose. In reality, therefore, sectors with weak or no pigment forming tendencies may and do occur on steamed rice, on oatmeal and other agars, only they escape notice because of the masking effect of the substratum. Similarly, slow growing sectors may and do occur in the more rapidly growing colonies; irregularities in the margin of the colonies, deep clefts and heart-like effects are often caused by such slowly growing regions, and unless immediately isolated, they will soon be surrounded with and lost in the more rapidly proliferating regions of the colony. The writer has isolated a number of such slowly growing strains from a fast growing culture of *F. moniliforme*. Characteristic patterns in the margin of colonies may also be isolated and perpetuated if detected and transferred before they become again lost in the fast advancing margin of the mother colony.

When a piece of inoculum is transferred into a solution containing some more or less toxic substance, it either grows or does not grow. When growth does occur, we assume that every cell of the inoculum withstood the effect of the toxic substance. But such is not always the case, as a microscopic examination of the inoculum, shortly after a growth begins to appear, will reveal the interesting fact that many of the hyphae are killed. A similar phenomenon will be manifested if a vigorously growing mycelium is transferred to such a solution, kept there for two or three days, and examined again. When the inoculum fails to make any growth in the presence of a toxic substance, we assume that it is either inactivated or killed. But a microscopic examination may often show scattered pieces of turgid hyphae among others with advanced stages of plasmolysis. If retained in culture long enough such an inoculum may regenerate into a vigorously growing colony. It is quite apparent that not all the cells of the same mycelium are physiologically identical, and that if we could accurately separate them, new phases in the life of a given species would be revealed. Similarly, when a certain strain of bacterium brings about agglutination, we cannot say that every individual cell of the bacterial colony is endowed with such an ability, just as we cannot say that in case of a negative result every individual cell of the colony was devoid of this power; else how can a culture become spontaneously agglutinative at one time and then fail of agglutination at another? The masking effect of the sheer weight of numbers is probably a factor in such cases; perhaps very few cells in a colony may possess the ability of agglutination, but their activities remain too limited and crowded to become noticeable. The same holds true in case of pathogenic relationships whereby disease producing and harmless phases follow each other in the life of an organism.

The secret of "inducing" dissociative phases does not lie only in bringing the organisms in contact with proper stimuli, but also in being on the lookout for small and seemingly insignificant deviations in the colony habit of a given fungus. A few different agars, thin and transparent layers of petri dish cultures, and as many cultures as possible are the most important beginning points. When colonies begin to form, they should be examined daily, and any region showing the slightest variation from the mother colony should be transferred to another culture dish and watched. Once a culture begins to "break up" it may continue until many "new" strains are produced. The writer proceeded to "induce" dissociations in a strain of *F. moniliforme* which had behaved quite regularly and showed no apparent sectors; two months later 50 distinct strains were isolated from this one monosporic culture; some of these are so obviously different in appearance and behavior as to fool the most conservative taxonomist concerning their origin. Even a "pure" colony, therefore, is often an aggregate of different phases and potentialities which can be separated from one another and kept for varying lengths of time.

It may be said that if the newer phases cannot be perpetuated without the tender care of the investigator, and the "normal" type will usually assert itself, there is no necessity of separating them and thus complicating the work of the taxonomist. Unfortunately we have numerous instances where the newer phases outgrow the old. Confusion can be averted only when all the possible dissociative phases of a given strain are brought to light and studied.

The work of Löhnis and Smith (6) on the life cycle of bacteria shows many points in common with the dissociation phenomena in Fusaria. They found that a given Azotobacter can develop a great number of unbelievably diverse morphological and physiological characters, and that such radically different types may appear one after the other during the lifetime of the organism. Perhaps these authors were dealing with the effect of bacteriophage, but that does not change the fact that even a bacterium is very complex in nature, possessing many phases and cycles in its life. Smirnow (9), Kan-Ishiro (5) and a great many other bacteriologists have conducted careful experiments with variations in bacteria, and have demonstrated the existence of a great complexity in the life cycles of pathogenic microbes. Rosen (7) has reviewed much of the literature concerning variation in bacteria, and, in addition, has studied this phenomenon himself. He calls attention to the fact that the conditions provided for the so-called normal growth of bacteria often preclude the possibility of obtaining other structures which might develop in the same species under more natural conditions. Nevertheless, he points out that variations may occur not only because of the appearance of different phases in a given life cycle, each with

its own set of forms and functions, but also because of racial or clonal differences within a species.

The most thorough review of the work on bacterial "mutations" and dissociations is that of Hadley (3) who cites 518 references bearing directly or indirectly on this subject. In addition, he has done a considerable amount of work himself, and therefore more than a passing reference should be made here to his publication, especially in view of the fact that there is a remarkably close parallelism between the behavior of a great many species of bacteria and that of the Fusarium species described in this paper. Extensive and intricate cases of bacterial instability have been accumulating for the past three decades, and it seems that pure-line colonies of many bacterial species are not composed of identical cells, as the orthodox school of taxonomy would lead us to believe, but that they contain certain new strains, bearing no resemblance to one another or to the parent type. Undoubtedly a biological mechanism backed by microbial heredity lies at the bottom of such dissociations. The new strains which make an appearance may persist for a time in an apparently stable state, or may become transformed into still another type, or may revert to the original form. Thus, it has been observed that cocci may become rods and rods may become cocci or spirals, that forms of colony growth change overnight, that motility is lost or regained, that fermentation reactions are modified by time and opportunity, that spore formers lose this ability, that hemolytic activity comes and goes, that capsulated bacteria lose their capsules, and capsules are gained by noncapsulated forms. Again it has been observed that antigenic power vanishes and reappears, that cultures spontaneously become agglutinative or fail of agglutination, that virulent cultures become harmless and harmless cultures virulent, that microscopic forms become ultramicroscopic and presumably change into a virus type, and that any of these new types of behavior may become more or less permanently fixed. These dissociations or "mutations" may be enhanced by the employment of such factors as aging, changes in acidity of the medium, temperature changes, physical and chemical variations in food substances, presence or absence of oxygen, antiseptic compounds or dyes, microbial associations, the influence of specific blood or serum, body secretions and excretions, metabolic products of other organisms, and finally the bacteriophage. Hadley reasons that since such a multitude of diverse factors is capable of bringing about dissociative phenomena among bacteria, it is probable that there is a common factor in bacteria directly influenced by such environmental changes, and he indicates arrested growth as such a condition. Consequently, any environment or substance antagonistic to the continued growth of the so-called "normal" type of an organism may induce dissociations. For instance, the rod phase of the Shiga bacillus is susceptible to bacteriophage whereas the coccus phase is

not, and when attacked by the ultraparasite, the bacillus phase disappears and the coccus phase emerges to carry on the life activities of the organism. Similarly old age, high and low temperature, toxic substances, etc., merely serve to suppress one phase in the cyclogeny of the organism and release the other. A given quality, be it morphological or physiological, may lie dormant or only slightly active in the protoplasm of the microbe for lack of the proper stimulus, but as soon as opportunity arises, this hidden and hitherto unsuspected quality expresses itself. Such changes may last for only one, two, or a few generations and go back to their dormancy again, or else they may be more or less permanent as has been demonstrated by many bacteriologists and as seen in Fusaria.

Knowing the possibility for dissociations of far-reaching significance, it is the duty of the investigator not to avoid the employment of the necessary stimuli, as some suggest, but rather to make full use of such stimuli. We may hand-pick our laboratory conditions, but we cannot exercise an effective supervision upon the behavior of fungi in nature where all sorts of physical and chemical conditions are in a perpetual state of turmoil. We may never be able thoroughly to know any one species, but the only way to gain a working knowledge of the "private life" of an organism is to stimulate the emergence of all of its phases and hidden facets.

Some of the conclusions drawn by Hadley are very pertinent and applicable to mycology. The writer is so heartily in accord with them that he cannot refrain from quoting a few. Speaking of the "normal" bacterial type Hadley states that "through long years of laboratory studies we have come to regard as the normal type that form of the organism which grows best for us on artificial culture media . . . 'normal culture' or 'normal type,' in the absolute meaning of these terms and as commonly employed, is something of a myth. The stock typhoid organisms which we maintain in the laboratory are not the same in all respects as those found in the blood or intestines, nor the same as those isolated from urine or gall bladder of typhoid convalescents. . . . Shall we regard as normal the disease form, the convalescent form or the old laboratory form? When we speak of normality or abnormality, we must make our comparison not between different stages in the cyclogeny of the strains, but between corresponding stages. In other words, we must compare S type culture with S type, R type culture with R type, and intermediate with intermediate. . . . Some of the greatest sources of confusion and error, not only in systematic but also in applied bacteriology are to be found in our well entrenched habit of attempting to make comparison between fundamentally different things, that is to say, between cultures in different cyclogenic phases of development. I believe, moreover, that until this viewpoint is changed no successful advance can be made through the commonly used methods of classification of bacterial species or

races or strains by seeking to establish 'serologic types' as an end in themselves . . . it seems to me that we have arrived at a point in the development of the science of bacteriology where much work on elaborate superstructures must be suspended until we have made more stable the foundation."

Hadley believes that the time will come when the mere naming of an organism will not mean very much in taxonomy, "for it is becoming increasingly clear that we shall never know what a bacterial species really is until we acquaint ourselves with the outermost limits of its variability. Our exact knowledge of an organism may be slight even after we have noted its morphology, recorded its measurements, registered its reactions, ascertained its common serologic and antigenic characters and given it a name." Before there is a possibility of reorganizing the present inadequate conception of the nature of bacterial species and of the systematic relationships of bacteria, it will be necessary to abandon, for the present at least, "our vain attempts to perfect schemes of classification." Furthermore, it will be imperative to initiate "a somewhat new branch of bacteriological study in which we shall strive to recognize bacterial species relationships, not by comparison of isolated single cultures of this or that, but by a study of all the various types or stages comprising the cyclogeny of the species in question —a difficult but necessary task. . . . *Bacillus diphtheriae,* as assumedly typifying a definite bacterial species, should eventually come to mean to us not merely a rod of fixed size and shape (possessing certain constant biochemical, serologic, immunologic, and staining reactions, by means of which it can conveniently be recognized and cataloged), but in reality a host of things, which we must be able to recognize individually and collectively."

Because Fusaria behave very much like the bacteria possessing cyclogenic and dissociative properties, and since the taxonomy of this genus is far from being perfect or even comprehensive, solutions offered by Hadley for the taxonomic puzzle of bacteria should be applicable to this and similar groups of fungi.

The fluctuations in vital responses which a given strain of fungus can manifest under even the most uniform environmental conditions seem to bear a pertinent relation to the occurrence of plant diseases. Why, for instance, are many diseases sporadic in nature notwithstanding the constant presence of host and parasite on the one hand and favorable environmental conditions on the other? Why may artificial inoculations fail even though the best of conditions for successful infection have been provided? Why is it that some plants are easily attacked and others show an apparent immunity? Is it not possible that the biological conditions of the parasite as well as those of the host plant may be responsible for this? Environmental factors have been constantly brought forward to answer these questions;

and, while no one can deny the great potency and the influential rôle of the environment, the biological mechanism of the parasite should not be relegated to comparative obscurity. Since dissociations enable the fungus at one time to withstand toxic substances and unfavorable factors and thus grow unhindered, and at other times to be totally inactivated or even killed, it is only logical to assume that similar conditions may, at one time, enable the parasite to overcome the resistance of its host, and hinder it from doing so at other times. Since most of the resistance offered by the host seems to be of chemical origin, it is clear that factors which control the ascendency of host and parasite in their struggle are to be found not wholly in the environment, or in the chemical and physical conditions of the host plant alone but also in the ever-shifting qualities of the parasite itself. A proper understanding of dissociative phenomena and an adequate control of the internal mechanism of fungus protoplasm seem to offer the most vital and the least explored field in plant pathology.

CONCLUSIONS

It is concluded that, notwithstanding the great variability, the inconsistency of certain morphological and physiological characters, and the appearance of a number of new characteristics in many Fusaria, a certain specific line of behavior persists throughout all of the strains and variants of a given fungus species. The path of the species may run in a zigzag line, but so far as the present experiments are concerned, it does not exceed the specific orbit.

None of the tests, when used either alone or in combination, should be deemed sufficiently dependable for the identification of species or varieties. However, if added to the more stable morphological and pathological characters, such tests may solve some of the perplexing questions in the taxonomy of fungi. The presence of distinct strains and variants within the same species, and their decidedly different reactions seem to indicate that the concept of the species must not be that of a single organism but that of a group of many organisms having in general the same principal characters.

Just as many of the physiological reactions, if used alone should not be considered specifically conclusive, similarly, because of the erratic occurrence of the types of sporulation, of different macroscopic mycelial characters, of color production, and of nonnegligible fluctuations in the size and the shape of spores, such characters alone cannot be considered dependable or of very great taxonomic value. Students of fungi should always be on guard against the pitfalls of chance variations, and should depend only upon thorough, well controlled, standardized, and repeatedly checked studies of morphology, physiology, and pathological affinities of the organism.

SUMMARY

1. It has been the purpose of these studies to trace the variability of Fusarium species and to demonstrate the continuity of the specific path which is believed to persist in all the strains of a given species regardless of numerous sharp deviations from the known specific behavior.

2. Cultures of Fusaria, obtained from various sources under 96 different specific and varietal names, were used in these studies. Some of these were originally received from two to seven different sources and for the sake of convenience have been called strains.

3. During the study many of the cultures, all of which were supposed to be pure, showed segmentations in the colonies. These were separated in pure cultures and termed variants. In some cases these variants continued to remain different from their parent types. In others there was a reversion to the original type, or a constant fluctuation back and forth.

4. About 220 cultures were studied. All were tested from the standpoint of rate of growth of colonies, production of color and spore masses on five different agars, sporulation on malt extract agar, growth at 5°, 25°, 34°, and 37.5° C., growth and reproduction in presence of nine different concentrations of tartaric acid, growth in presence of two concentrations of tannic acid, two concentrations of mercurochrome, five concentrations of malachite green, two concentrations of iodic acid, one concentration of acid phenyl acetic, two concentrations of sodium dinitrophenoxide, and three concentrations of sodium tribromphenate.

5. The foregoing tests showed that not only different species, but even some of the strains and variants of the same species manifested decidedly different reactions in the foregoing tests. However, many strains and some closely related species often showed strikingly similar responses.

6. Even under controlled conditions the reaction and behavior of many organisms are extremely erratic.

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EXPANATION OF PLATES

PLATE XVI.—*Fusarium coeruleum* dissociating (upper colony); the two strains separated (lower colonies).

PLATE XVII.—*Fusarium tirchothecioides* 2 dissociating (upper colony); the two strains separated (lower colonies).

PLATE XVIII.—*Fusarium trichothecioides* 3–I and 3–II (upper colonies). *Fusarium solani minus* I and II (lower colonies).

PLATE XIX.—*Fusarium martii* 3 dissociating (upper colony); the two strains separated (lower colonies). Very rarely was a pure colony of the blue form, as shown in fig. C obtained in petri dish cultures. For nearly two years whenever a transfer was made from this strain it gave rise to a complex colony composed of white and blue sectors. While the white form was relatively more stable, it did, occasionally, give rise to blue sectors. A number of single spore cultures gave the same kind of results. Then suddenly all blue color disappeared and has not been observed since. Transfers made from stock cultures with deep blue color yield nothing but pure white colonies.

PLATE XX.—Two colonies of *Fusarium semitectum* 1 dissociating.

PLATE XXI.—Some of the strains of *Fusarium semitectum* 1. The variant I is extremely unstable as can be seen from the first two colonies. A great number of attempts to fix the type met with failure.

PLATE XXII.—Three types of dissocations in *F. tricinctum* 1.

PLATE XXIII.—The variants of *F. tricinctum* 1. Note that variants I and VII show a complex type of colony. At present time of writing this dissociating habit has disappeared.

PLATE XXIV.—*Fusarium martii phaseoli* 2 dissociating (upper two colonies); the two strains separated (lower two colonies).

PLATE XXV.—The three strains of *Fusarium martii phaseoli* 1.

PLATE XXVI.—*Fusarium eumartii* 1 dissociating (upper colony); the two strains separated (lower colonies).

PLATE XXVII.—*Fusarium eumartii* 2 dissociating (upper colony); the two strains separated (lower colonies).

PLATE XXVIII.—*Fusarium striatum* 1 dissociating (upper colony); the two strains separated (lower colonies). The petri dish, from which the upper picture was taken, was inverted in order to show the nature of segments more clearly, hence the apparent difference in the growth habit of the colonies.

PLATE XXIX.—*Fusarium fructigenum maius* 2 dissociating (upper colony); the two strains separated (lower colonies).

PLATE XXX.—*Fusarium culmorum* 1 showing reversible dissociations. The colo-

nies, shown at A and C have reverted to one another quite often, while the type illustrated by B has appeared only sporadically. All efforts to fix the types have been futile.

PLATE XXXI.—*Fusarium herbarum gibberalloides* showing the two strains.

PLATE XXXII.—*Fusarium culmorum* 3 dissociating (upper colony); the two strains separated (lower colonies).

PLATE XXXIII.—*Fusarium acuminatum* 2. At the time when this picture was taken all four colonies were of the same age and had been growing under identical conditions. Note the "regeneration" of the colony at C where the white, compact growth has formed a loose and rapidly growing mycelium. Transfers made from such fast growing regions to plates of nutrient agar yielded very slow-growing colonies. These erratic growth habits conitnued for six months or so and then suddenly disappeared. Now all of the eight strains which were thrown off by the original culture are rather rapid-growing organisms.

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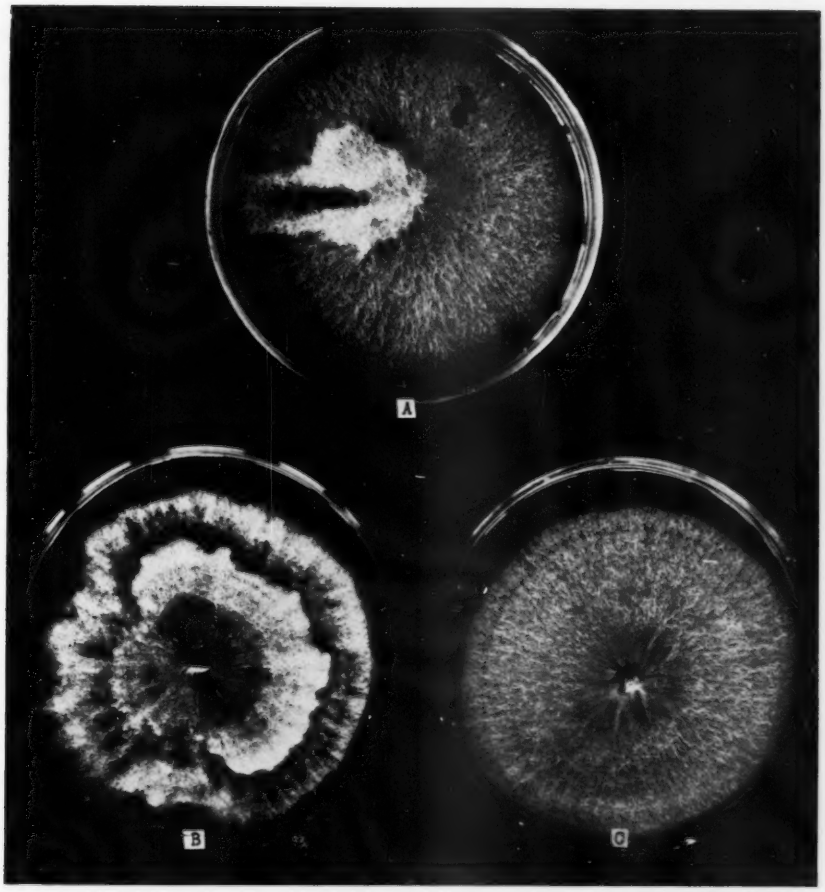
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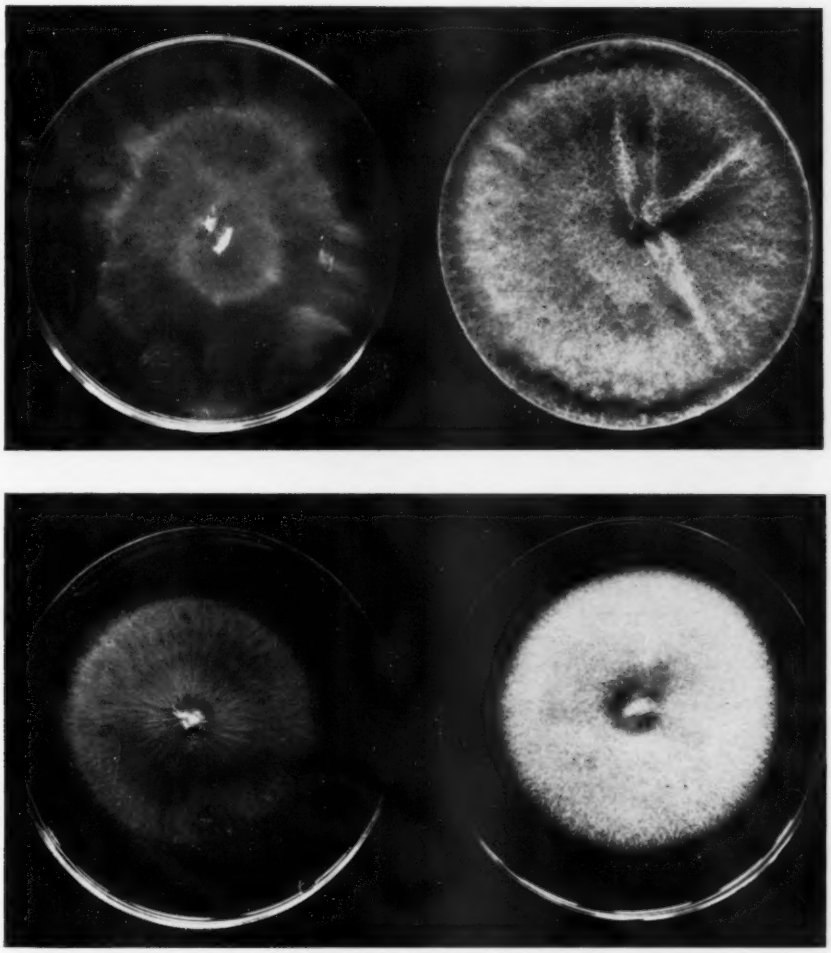

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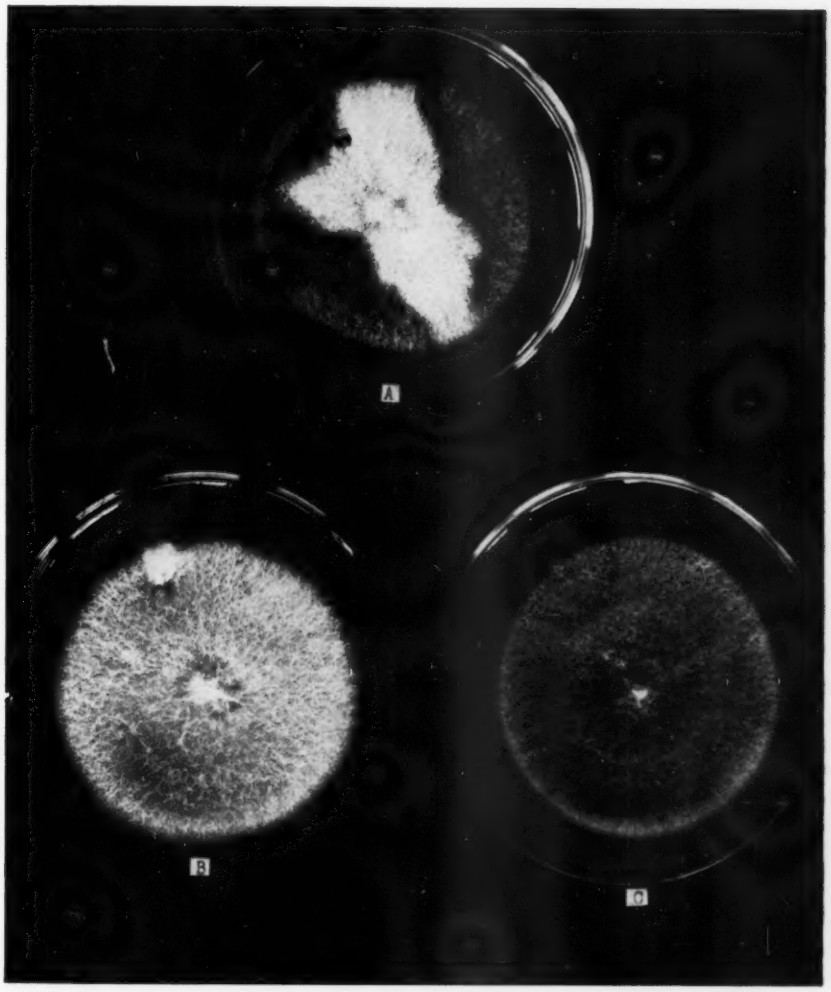
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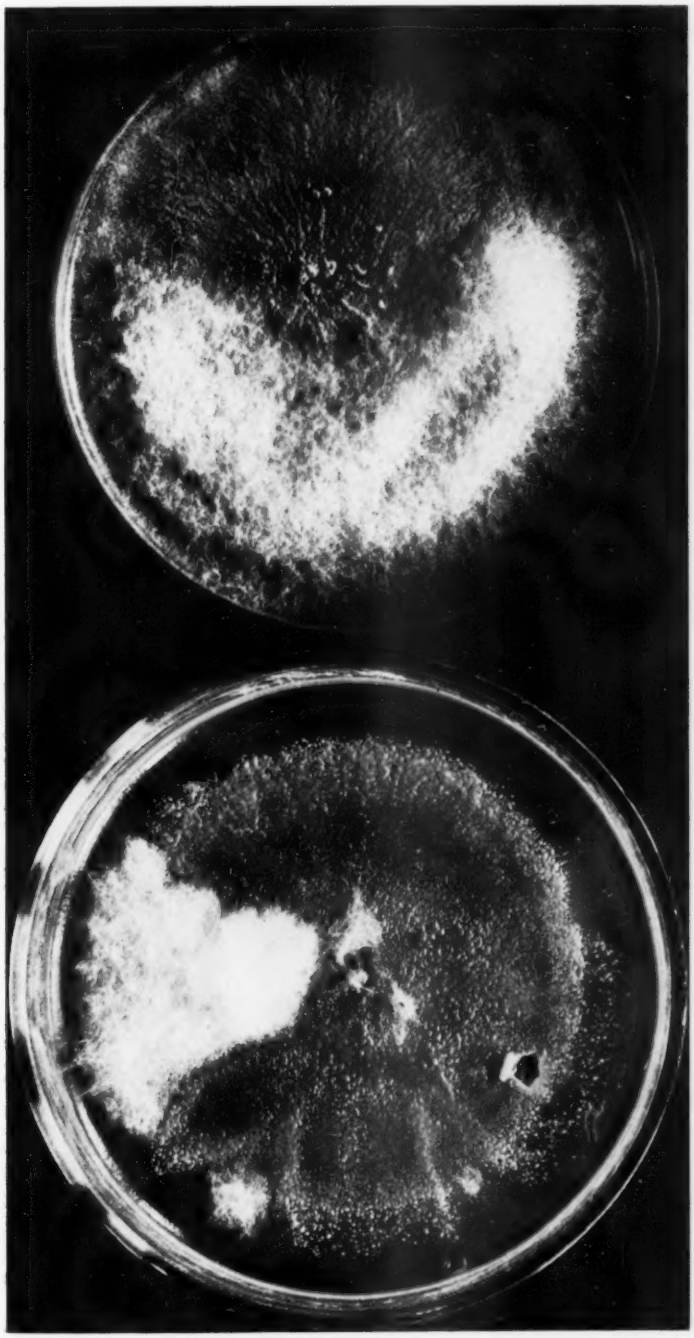

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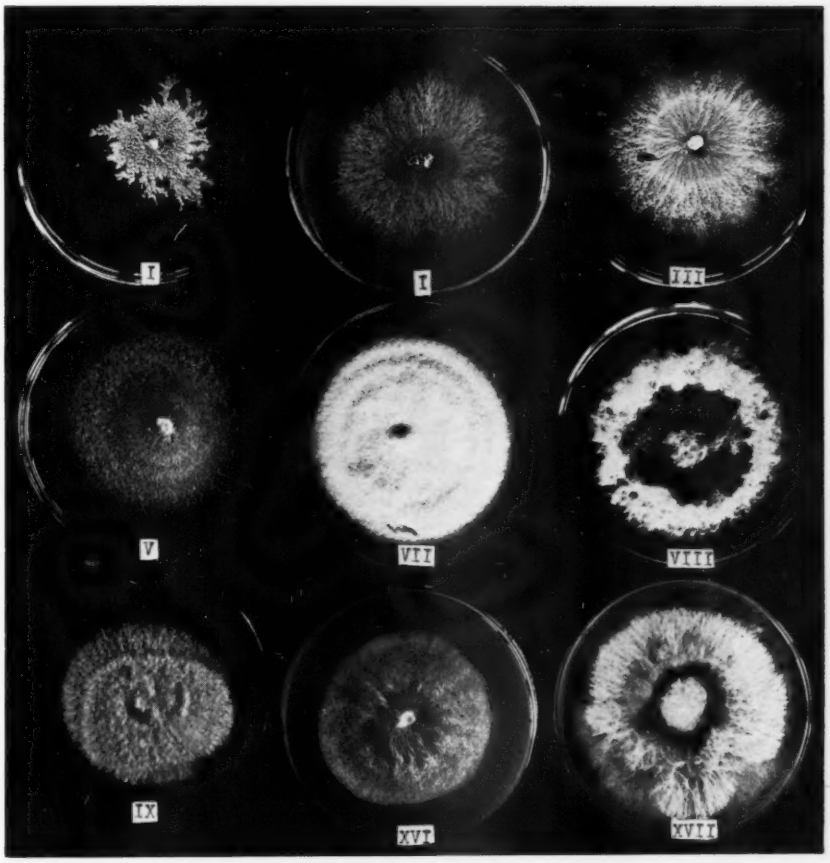
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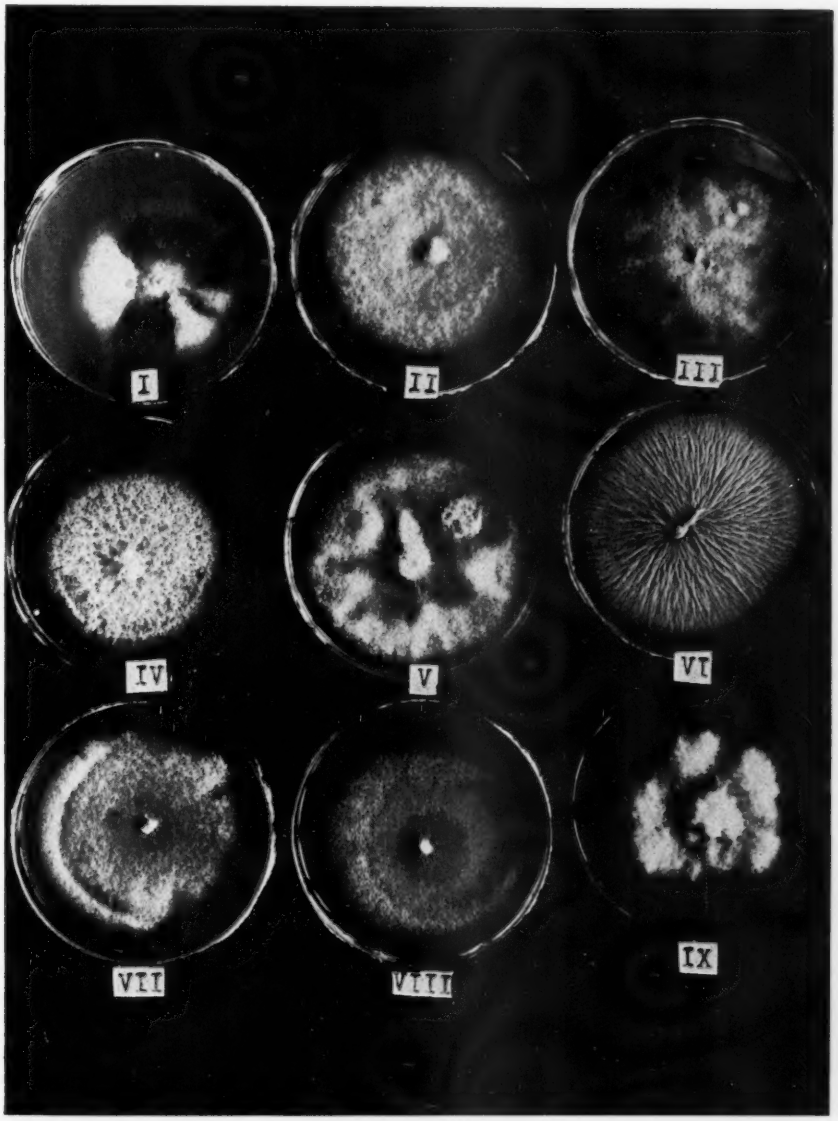
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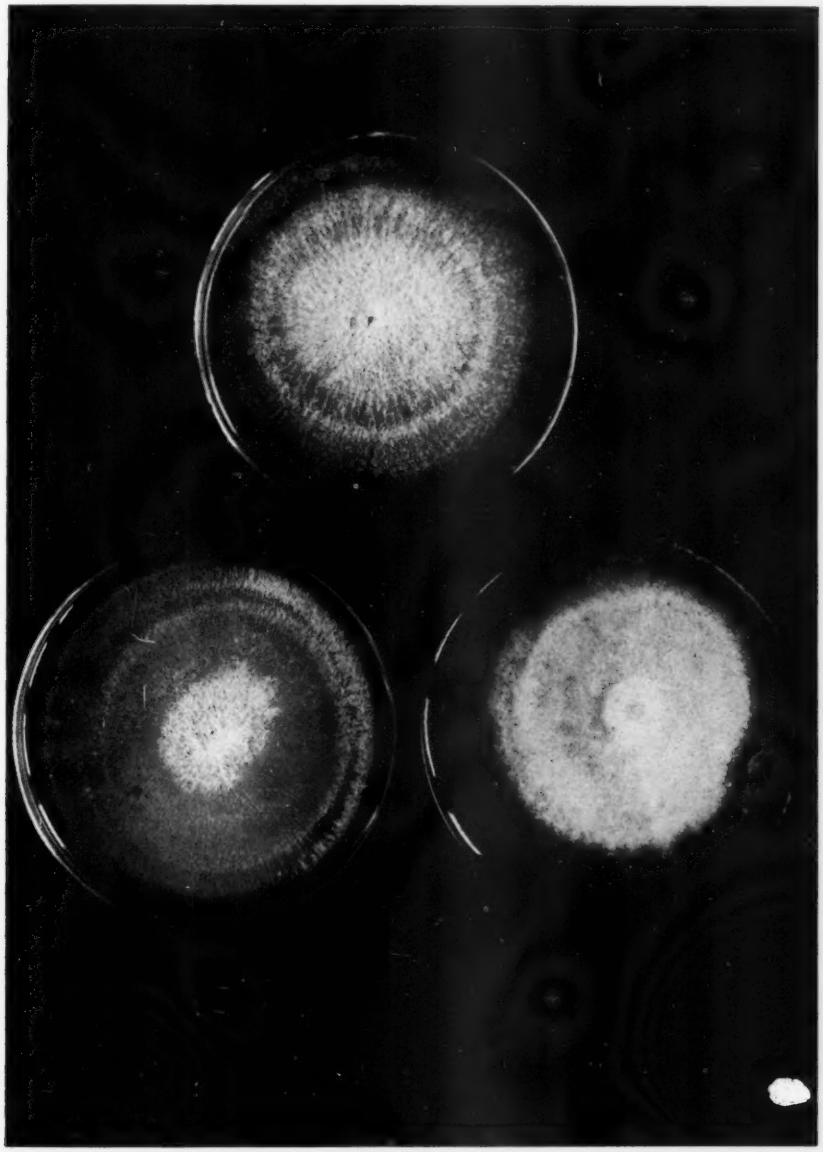

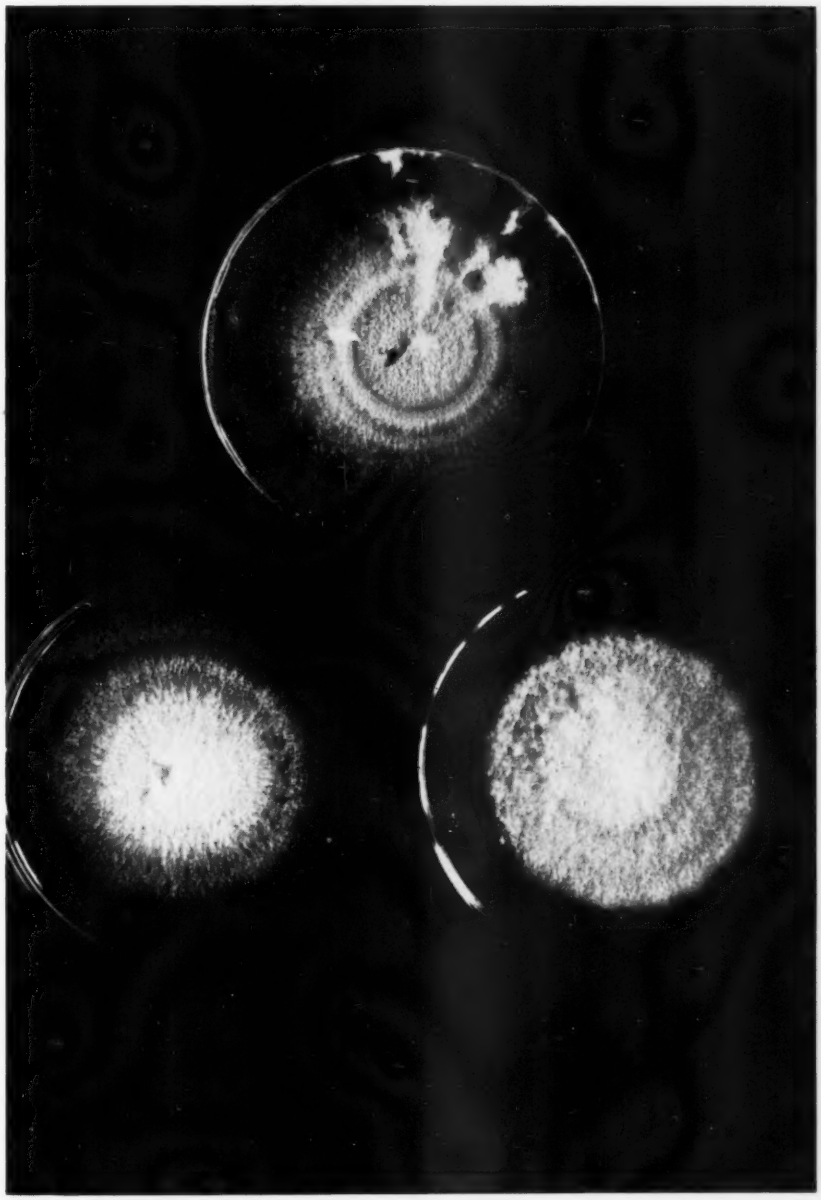

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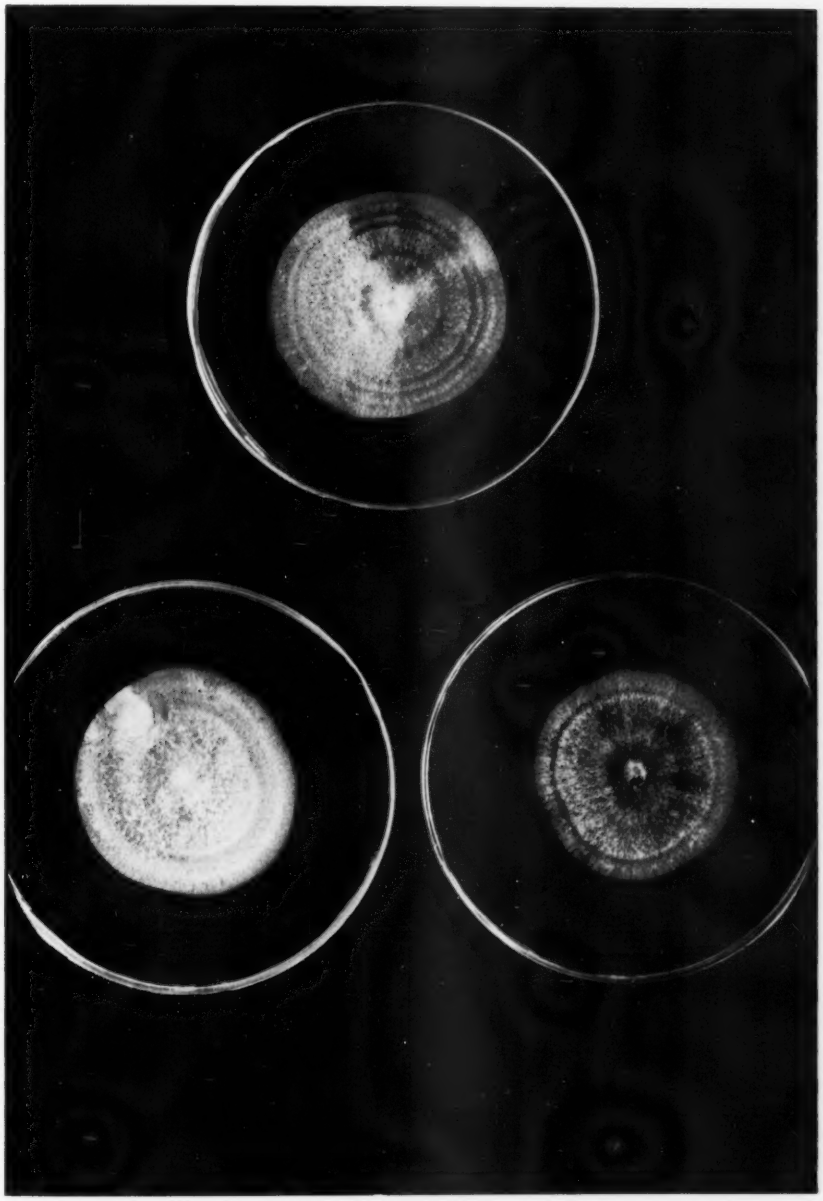

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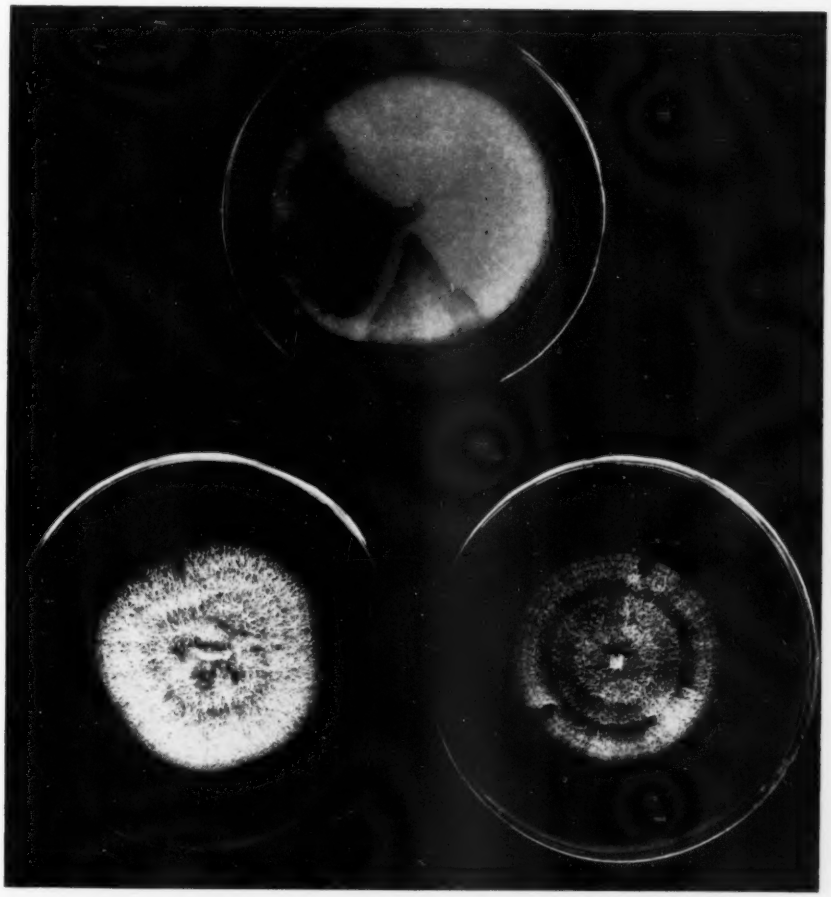

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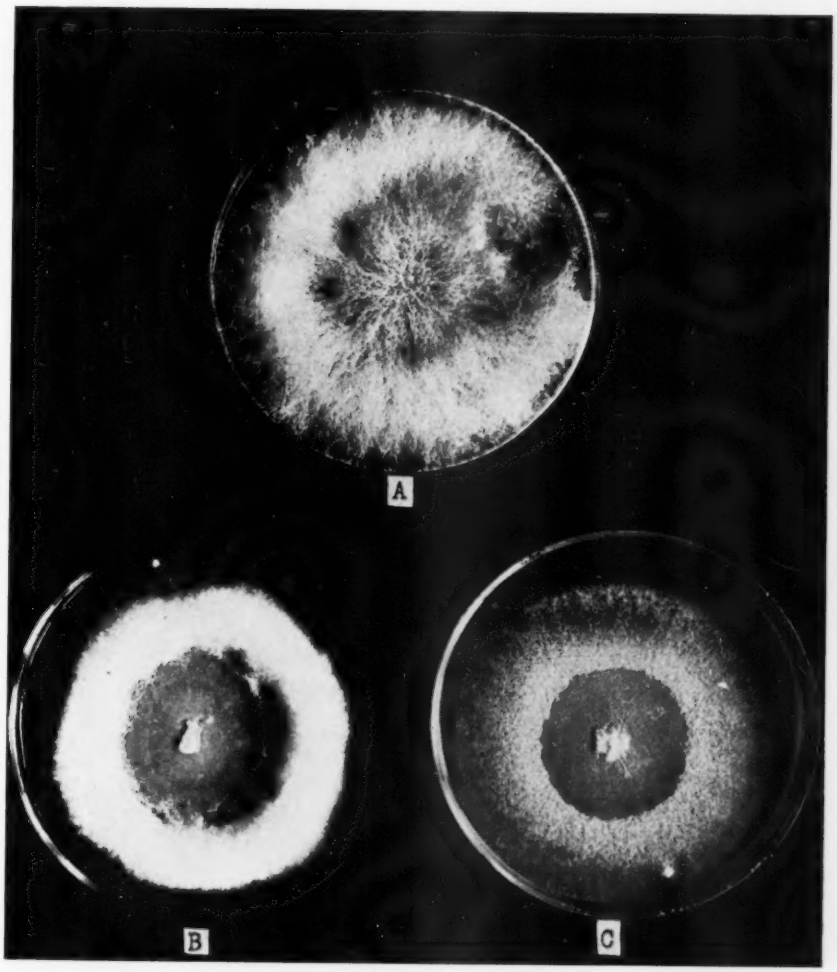

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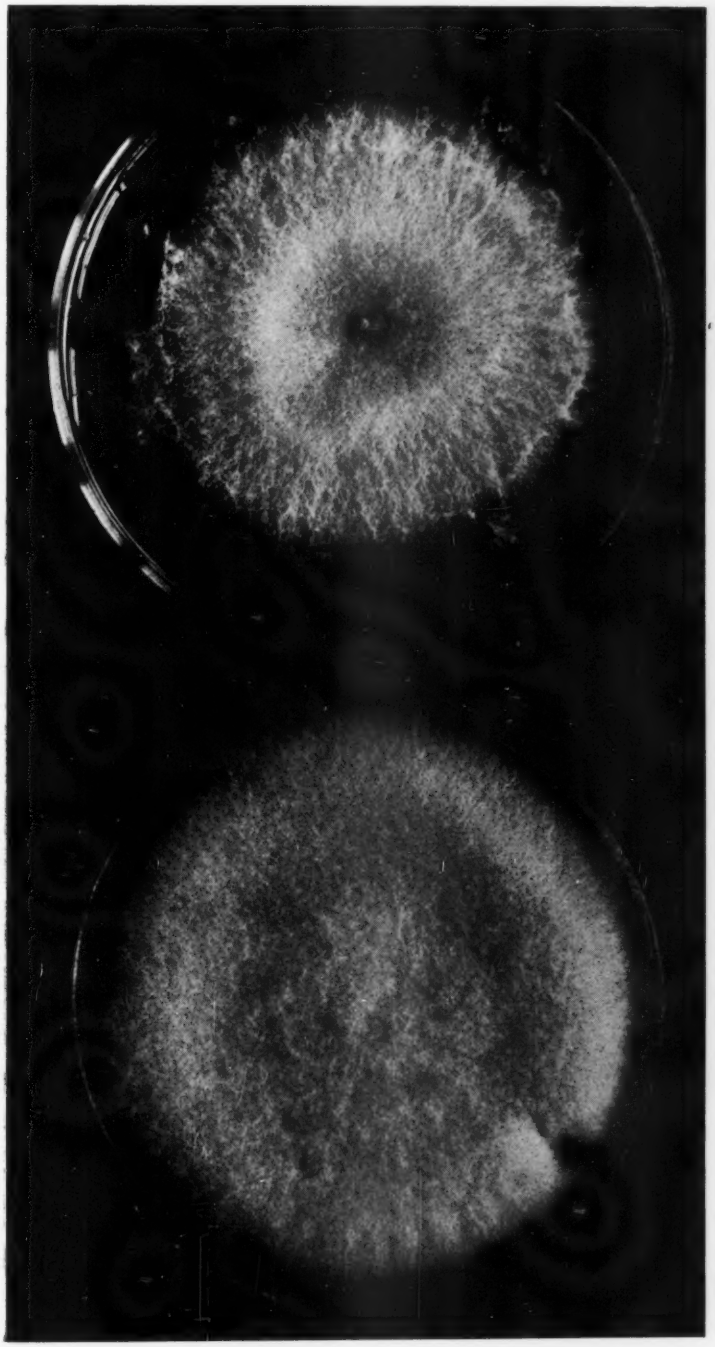

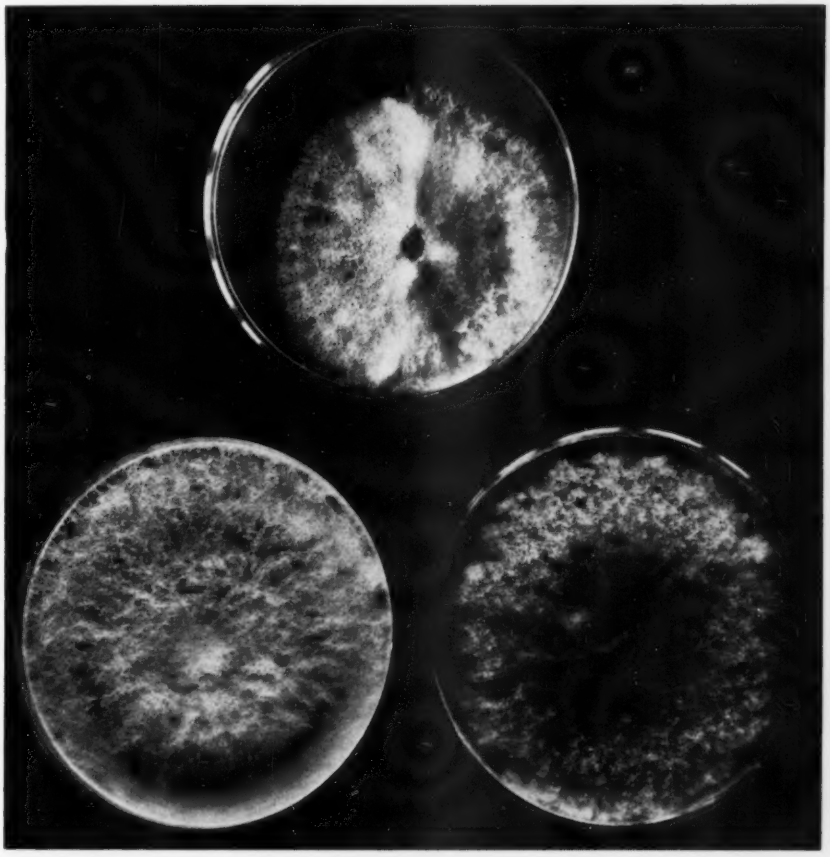

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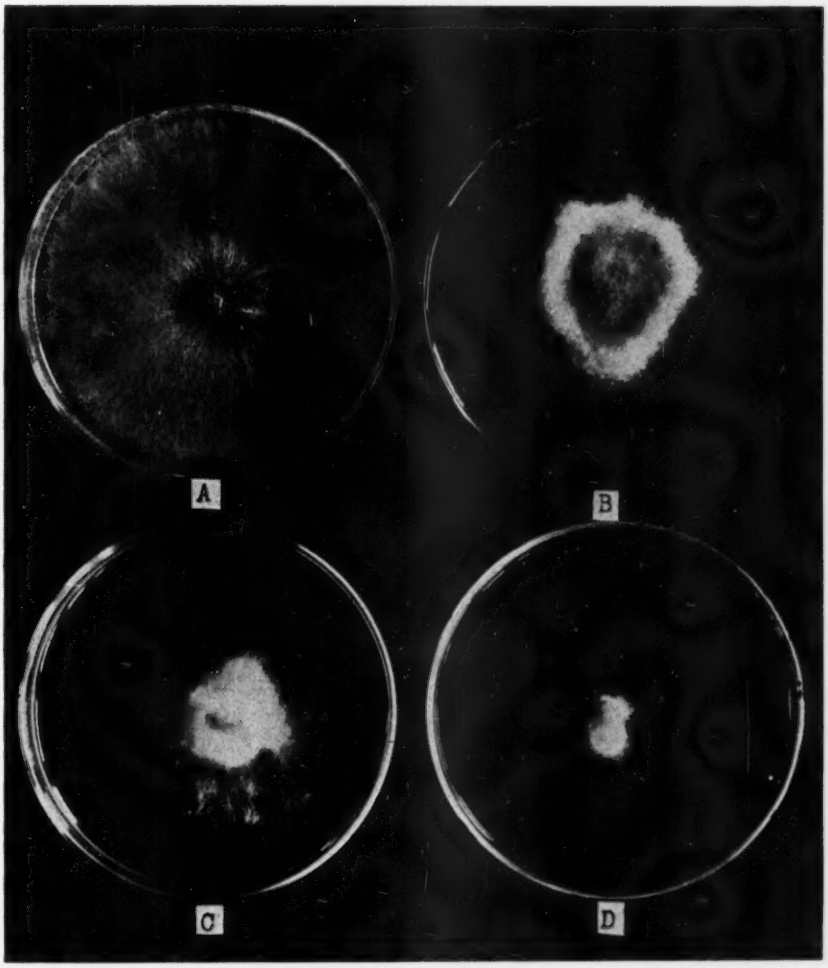

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OBSERVATIONS ON ARMILLARIA ROOT ROT OF ORCHARD TREES

LEROY CHILDS AND S. M. ZELLER

INTRODUCTION

The root-rot disease of fruit and nut trees caused by *Armillaria mellea* Vahl is very prevalent in certain sections of the Northwest; in fact, in western Oregon the fungus is much more prevalent than is indicated by the death of orchard trees. This would seem to be due to the fact that the most prevalent strain of this species apparently does not attack roots of deciduous trees. The purpose of this paper is to report observations on two apparent physiologic strains of *Armillaria mellea*. One of these, it would seem, inhabits the roots of conifers, especially Douglas fir (*Pseudotsuga taxifolia* (Poir) Britt.), in the forests, while the other strain is found conspicuously in oak-cleared land. The latter is so consistently associated with the oak in the minds of orchardists and plant pathologists of the Pacific-Coast States that this strain of *Armillaria mellea* is now commonly known as the "oak fungus." For immediate convenience in this paper, these two strains will be designated the "fir and oak strains," respectively.

THE FIR STRAIN

For several years previous to 1920 the senior author had noticed a great many orchard trees possessing practically a complete network of rhizomorphs about the larger roots and crowns. These were in every observable respect similar to those associated with trees infected with Armillaria root rot. Some of these trees were observed for a number of years. Apparently there were no infections and the trees in all such cases remained sound and maintained normal vigorous growth, giving no indication of inconvenience due to the presence of the fungus.

In the fall of 1920, some interesting observations were made in a block of the apple orchard belonging to Childs and Graff at Dee in the upper Hood River Valley. The trees at this time were 8 or 9 years old. Of the 288 trees in the block, 164, or 57 per cent, were encircled at the crown by a dense collar of sporophores of *Armillaria mellea*. Careful examination revealed that the stems of the mushrooms were solidly attached to the bark of the trees at the ground line. A network of rhizomorphs were found, not only on the crown of the trees supporting mushrooms, but on all trees examined on which there were none. Figure 1 illustrates the relation of the mushrooms to the crown of the tree and shows the thick weft of rhizomorphs on the large roots.

FIG. 1. Crown of an apple tree showing fruiting bodies of *Armillaria mellea* and thick weft of rhizomorphs on the large roots.

The land where this orchard was planted was virgin, fir-cleared soil. Much débris of fir wood remained in the soil. We were able to trace rhizomorphs from the roots of apple trees to fir snags buried in the soil at depths of five feet.

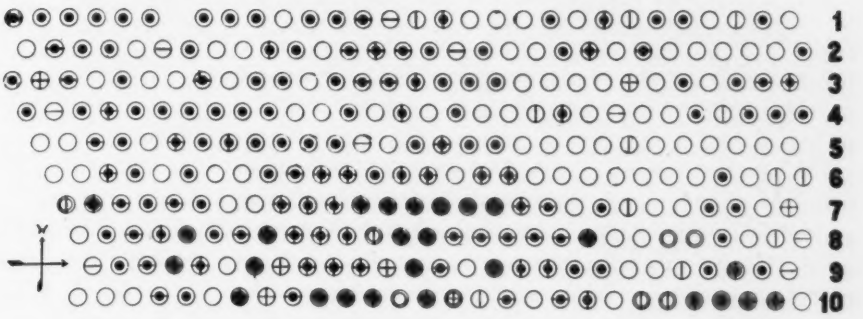
Several types of experiments were devised in the fall of 1920 to learn if wounds were necessary to permit infection by this fir strain of *Armillaria mellea*. In some instances apple roots were pruned and removed, leaving only the cut stub, while others were merely sawed off and left to decay in

the soil as an inoculum for the pruned stub. In other cases, roots were girdled by removing about two inches of bark; others were sawed to the pith and half cylinders of wood about two inches long were removed. These were again covered and observed in the falls of 1921 and 1922. After one or two years, these wounds had been thoroughly grown over by rhizomorphs but close examination revealed no infection whatever.

The occurrence of fruiting bodies of the fungus was checked on these trees from 1920 to 1924. The accompanying plot of the orchard (fig. 2)

PLOT OF APPLE ORCHARD ON FIR-GRUBBED LAND ILLUSTRATING THE PRESENCE OF ARMILLARIA MELLEA AS INDICATED BY THE OCCURRENCE OF ITS FRUITING BODIES AROUND TREES DURING THE YEARS 1920-1924.

FRUITING BODIES IN 1920-◉, 1922-⊖, 1923-◐, 1924-○



gives the number of trees bearing fruiting bodies each year. There were no mushrooms around the trees in the fall of 1921, due perhaps to the fact that the very light precipitation came late, and the first period of moisture sufficient to induce fruiting of the fungus came simultaneously with freezing night temperatures. In 1922, 1923, and 1924, there were 30, 28, and 30 per cent, respectively, of the trees surrounded by mushrooms. Unfortunately, in 1924, records were obtained on 4 rows of trees only. During the five years, 69 per cent of the trees had mushrooms of *Armillaria mellea* growing around them one or more seasons.

In the fall of 1925, when these apple trees were 13 or 14 years old, they were pulled out. The roots of all the trees were covered with a mesh of rhizomorphs but with the exception of one lone root no infections were found. In the neighboring fir forests there are occasional oak trees and it is possible that an oak sometime stood near the edge of the plot where this infected tree was removed. When the trees were pulled, they were in vigorous condition, having had an unusually good color during the previous summer.

Many other instances illustrating the saprophytic nature of this fir-strain of *Armillaria mellea* have been observed in the Willamette Valley, Oregon. These were mostly cases where one or more oak trees were known to have been present in an otherwise pure stand of fir on land now devoted to prune or walnut orchards. In the Skyline Orchards, near Salem, were found examples of mushroom root rot in which prune and walnut trees were dying in rather definite areas where oak trees were konwn previously to have occupied the land. The remainder of the orchard was mostly on fir-cleared land. The roots of many of the trees in these portions of the orchard were well covered with a network of Armillaria rhizomorphs but in all cases the trees were vigorous.

It may be that this fir strain of *Armillaria mellea*, as found in the Pacific Northwest of the United States, is distinct from that found on conifers in Europe. The following statement by Van der Meer[1] and similar expressions by other European workers would indicate parasitic virulence rather than a saprophytic nature of the strain from conifers in Europe. She says, "In 1922 the author observed the great damage caused by *Armillaria mellea* in a cherry orchard . . . which was planted on fir soil."

THE OAK STRAIN

On the other hand, in all instances where Armillaria has evidently had its source in the native oak (*Quercus garyana* Dougl.) virulent infection is the rule. Many cases could be cited in the Willamette and Hood River Valleys in Oregon. Hendrickson,[2] in California, says "it is not difficult to find, in orchards which have been long owned by one family, authentic cases where the disease has developed in areas from which oak trees had been removed many years before." He also gives the history of a typical orchard infected from oaks which were cut down some 30 years before. Undoubtedly other native vegetation also acts as a source of infection but circumstantial evidence at least would point to the virulent strain in the Pacific Coast States as having its origin in oak or similar wood.

One of us[3] recently described two modes of root infection by this oak strain, besides the entrance through wounds. Some have reported infection through graft unions but we have not observed such cases. Nevertheless, it would seem that crown infections are common in older trees where the graft unions are as smooth as any other portion of the crown. Since the crown

[1] Van der Meer, J. H. H. Verticillium wilt of herbaceous and woody plants. Med. Landbouwhoogesch. Wageningen **28:** (2) 1–82. 1925. (See p. 62.)

[2] Hendrickson, A. H. Oak fungus in orchard trees. Calif., Agr. Exp. Sta. Circ. 289–13 p. 1925.

[3] Zeller, S. M. Observations on infections of apple and prune roots by *Armillaria mellea* Vahl. Phytopath. **16**: 479–484. 1926.

gives rise to many adventitious stem and root buds, it may be that the crown infections occur through the points of their emergence, as previously described.[4]

In conclusion, it should be said that macroscopic or microscopic examinations and comparisons of the sporophores from the oak and fir strains of Armillaria reveal no appreciable differences in morphology, color, etc.

SUMMARY

This paper presents the histories of typical cases of *Armillaria mellea* on roots of orchard trees planted on (1) fir-cleared land and (2) oak-cleared land. There is evidence of two distinct physiologic strains of the fungus. The oak strain is parasitic, while the fir strain apparently is not.

OREGON AGRICULTURAL EXPERIMENT STATION,
CORVALLIS, OREGON.

[4] Zeller, S. M. *l.c.*

THE EFFECT OF GRAFTING ON RESISTANCE AND SUSCEPTIBILITY OF BEANS TO *COLLETOTRICHUM LINDEMUTHIANUM*[1]

J. G. Leach

In an earlier paper (3) on the parasitism of *Colletotrichum lindemuthianum* (Sac. and Mag.) Bri. and Cav. the author described the development of the fungus in resistant and susceptible hosts and concluded that the scant growth and subsequent death of the fungus in a resistant host were due to starvation. The observed phenomena seemed to indicate inability of the fungus to utilize the food materials elaborated by the protoplast of a resistant plant, while it could readily utilize that elaborated by a susceptible host. However, it was shown that the fungus would grow equally well on sterile, unheated, expressed sap of either resistant or susceptible hosts. This would indicate that the cell sap was essentially modified by extraction or that the inability of the fungus to utilize it before extraction was due to the manner in which it was held by the living protoplast rather than to the specific nature of the sap, itself.

Hoping to throw additional light on the problem, it was thought advisable to graft resistant and susceptible varieties and to observe the effect on resistance and susceptibility. Owing to pressure of other work, it was impossible to complete this phase of the work until quite recently. In the meantime, the effect of such grafting on susceptibility and resistance to other fungi by other hosts has been reported by several workers. Roach (5, 6) made reciprocal grafts of varieties of potatoes resistant and susceptible to *Synchytrium endobioticum* (Schilb.) Perc. He found that the nature of the scion had no effect on the resistance or susceptibility of the tubers developing on the stock. Plants grown from such tubers likewise were not altered in their reaction to the parasite. This work has been extended and verified by Köhler (2). Similar results were obtained by Salmon and Ware (7) who made reciprocal grafts with varieties of hops (*Humulus lupulus* L.) resistant and susceptible to hop mildew [*Sphaerotheca humuli* (DC.) Burr.].

On the other hand, Wormald and Grubb (8) presented evidence to show that when an apple scion, susceptible to crown gall, is grafted on a stock of a resistant variety the stock loses its resistance and becomes susceptible.

Hofmann (1) has made reciprocal grafts between several varieties of beans and between *Phaseolus vulgaris* L. and *P. lunatus* L. He found that

[1] Published with the approval of the Director as Paper No. 841 of the Journal Series of the Minnesota Agricultural Experiment Station.

[2] The major portion of these experiments was carried out at the Biologische Reichsanstalt, Berlin-Dahlem, Germany, while the writer was a fellow of the International Education Board. The writer expresses his appreciation to the International Education Board for its support and to the Director of the Biologische Reichsanstalt for greenhouse and laboratory facilities and for many other courtesies extended to him.

the longevity of the rootstock of *P. vulgaris* was increased by top grafting with *P. lunatus*. There was no evidence of the translocation of anthocyanin pigments from one graft symbiont to the other. Richmond (4) presented evidence to show that when a lima-bean top is growing on a navy-bean root a pure culture of the lima-bean strain of nodule bacteria will not form nodules on the roots of the grafted plants. On the other hand, when seeds are produced on such a plant or the reciprocal graft, they are so modified that plants grown from them develop nodules when inoculated with pure cultures of either strain of the nodule bacteria.

In the experiments reported here, two varieties of beans (*P. vulgaris*), one susceptible (Ruby Horticultural Bush, No. 21), and one resistant (Large Garapata, No. 20), to a physiologic form of *Colletotrichum lindemuthianum* were used. Reciprocal grafts were made soon after the first pair of true leaves were fully expanded. Two plants, one of each variety, were selected with epicotyls having approximately the same diameter. The epicotyls were severed with an improvised knife made from a Gillette safety-razor blade. A long, downward-sloping cut was made from each side, about half way between the top of the hypocotyl and the first pair of leaves, thus giving the scion a wedge-shape end which engaged a corresponding cleft in the stock. The scions were interchanged and loosely held in place with a small cotton thread. The entire point of contact was then painted over with melted paraffin applied with a camel's-hair brush. The plants were finally placed in a moist place for further growth. With care and a little practice a fairly high percentage of successful grafts were obtained.

Owing to the somewhat retarded growth of the scion, the latent buds just above the cotyledons usually began growth so that after about two to three weeks there was a set of developing shoots both on the stock and on the scion. These were then inoculated with the spores of *C. lindemuthianum* and incubated in the usual manner. Normal plants of each variety were always inoculated at the same time. In all, about 15 plants of each type of graft were inoculated. In no case was there any indication that the resistance or susceptibility was influenced by either stock or scion. (Fig. 1.)

In this type of graft both the stock and scion may carry on their own photosynthetic activities. It was thought that if one part of the graft were kept in the dark, so that it would have to depend upon the other part for its photosynthetic products, the results might be different. To test this, either the stock or the scion of the different combinations of several plants were enclosed by improvised boxes of black paper. Inspection showed that the enclosed leaves were devoid of chlorophyll after about 10 days. The boxes were removed and the plants were inoculated in the usual manner and incubated in a dark room. Here again the resistance or susceptibility was in no way modified.

FIG. 1. A, plant of the resistant variety No. 20; B, a grafted plant with a resistant scion and susceptible stock; C, a grafted plant with susceptible scion and resistant stock. All three plants were inoculated with the same physiologic form of *Colletotrichum lindemuthianum*.

These experiments would seem to indicate that, if resistance or susceptibility is due to a specific substance in the plant, this substance is not translocated from scion to stock or *vice versa*, or else it is modified by the cells which receive it.

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PHYTOPATHOLOGICAL NOTES

Polymorphism of Leptosphaeria coniothyrium (Fckl.) Sacc.—Pathologists have doubtless observed on both young and old twigs and stems of *Rosa* sp. slightly reddish, spotted and streaked, pimpled or water-soaked areas. These diseased areas crack and continue to increase in size and a callus forms over the cracks. Later, a definite canker may develop. On the leaf are spots not unlike those caused by Phyllosticta and Cercospora.

When isolations are made from the twig, stem, leaf, hip, and seed, a fungus is obtained which macroscopically resembles a yeast. It consists of budding cells that put out one or more protuberances resembling small ruptures or swellings which gradually thicken and then produce new ones similar to those from which they have arisen. The process continues and gives rise to various kinds of saccharomyces-like colonies. This appears to be the initial phase of *Leptosphaeria coniothyrium* and has been reported as *Polyspora* sp. and *Kabatiella* sp. In this note, this phase of the organism is designated as Pseudosaccharomyces.

A Pseudofumago phase is obtained from the budding of Pseudosaccharomyces. On the stem lesions and leaf spots and in culture, it forms short chains or glomerules composed of globular or ellipsoid cells simple or divided by one or two transverse septa and sometimes also by a longitudinal septum.

Transfers from these phases in culture have yielded a mycelium which has developed pycnidia. The conidia are at first hyaline and might be considered as belonging to Phyllosticta or Phoma; however, at maturity the spores become colored. It is evident that Coniothyrium is the name which should be applied to this phase of the fungus. There is also a wide variation in size of the spores.

Coniothyrium has also developed on the twigs, stems, hips, and seed from which Pseudosaccharomyces and Pseudofumago were isolated when the material was put in a damp chamber and kept warm for from ten to eighteen days.

A recent collection has been made from which all five phases, including Leptosphaeria, were obtained from the same canker. Single-spore isolations of *Leptosphaeria coniothyrium* have produced Coniothyrium in culture.

The Pseudosaccharomyces and Pseudofumago phases of the fungus have been isolated from material received from Connecticut, West Virginia, Georgia, Michigan, Indiana, and Kansas, and collected by the writer in New Jersey, District of Columbia, Maryland, and Virginia. It is concluded that *L. coniothyrium* is a polymorphic facultative organism with several phases in its life history.—G. Hamilton Martin, *Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.*

Tobacco Mosaic Control in Mexico.—In September, 1928, Mr. J. O. Menchaca, of Tepic, Mayarat, Mexico, visited the flue cured and Burley tobacco growing sections of the United States and during this trip called on the writer at Lexington, Ky. In discussing tobacco diseases, the writer showed Mr. Menchaca tobacco plants affected with true tobacco mosaic, and other virus diseases of tobacco. He stated that he had had tobacco mosaic pointed out to him by others on the trip, but that he had never seen it in Mexico. In view of the fact that more than 1000 acres of tobacco are grown under his direct supervision each year, the statement probably means that mosaic is extremely rare in his plantings. On questioning him as to the personal habits of the tobacco growers with respect to the use of tobacco, he stated that practically all of them smoked manufactured cigarettes made from Mexican grown tobacco. This tobacco is allowed to heat in bulk, a process which, in itself, is likely to kill the virus if it were present. While we know that many brands of American cigarettes carry the mosaic virus, the chance of spread from cigarettes to tobacco plants is comparatively slight as compared with using viruliferous chewing or smoking tobacco where the hands may readily become contaminated as a result of handling, and breaking or grinding the tobacco in the hands. Thus, even though viruliferous cigarettes were used by the growers during the pulling and setting season, the number of infected plants resulting would be extremely small, and cigarettes made from the resulting tobacco would be expected to be nearly free from infection. As personally used tobacco is apparently the chief source of introduction of mosaic into the field in Kentucky (Ky. Exp. Sta. Bul. 280), it seems fair to assume that such would be the case in other parts of the world, and that mosaic control in Mr. Menchaca's plantings is the direct result of the habit of the growers of using tobacco only in the form of manufactured cigarettes made from tobacco which we have reason to believe is free from mosaic.—W. D. VALLEAU, *University of Kentucky, Lexington, Ky.*

FINANCIAL STATEMENT OF LYMAN MEMORIAL FUND SEPTEMBER 10, 1929

Cash in bank on savings account	$ 412.44
Pledges	670.40
Total	$1,082.84

This is an increase of $367.84 since May 20 when the fund totaled $715. The number of contributors is 73 and the amounts of pledges and donations range from $1.00 to $100.